N° 5518 A.D. 1899

Date of Application, 14th Mar., 1899—Accepted, 8th July, 1899

COMPLETE SPECIFICATION.

Improvements in Electric Spark Gap Apparatus.

I, THOMAS BURTON KINRAIDE, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

The more recent developments in electrical matters, and particularly in the line of experimental research in connection with static electricity, has developed conditions requiring the discharge of such enormous potentials and amperage as to render the apparatus heretofore provided for such purposes inefficient and largely useless, for the reason that these enormous discharges which the electrician frequently desires to experiment or deal with very quickly render inoperative or destroy such usual apparatus.

Accordingly, it is the object of my present invention to provide a practically indestructible discharge apparatus to meet the more exacting requirements of the present day, and to that end I provide a spark gap which is virtually self-recuperative, and comprises opposite parallel discharge surfaces of considerable area, which, besides their practically indestructible character, possess numerous very important advantages all as will be more fully pointed out in the course of the following detailed description of the apparatus, reference being had to the accompanying drawings illustrative of preferred embodiments thereof.

In the drawings, Fig. 1 represents in side elevation a simple form of my improved spark gap.

Fig. 2 is a similar view shewing a modification.

Fig. 3 is a top plan view of the form of apparatus shewn in Fig. 2.

I provide electrodes preferably in the form of opposite parallel discs g, g^1, the air gap between whose frame surfaces constitutes the spark gap, the extended area of these electrodes preventing the tendency of the condenser (for example) with which my invention will ordinarily be used, to discharge until it has reached its maximum charge, and also causing the discharge to be exceedingly sudden when it does take place, and the discs not being liable to become unduly heated.

The spark gap constitutes virtually a self-recuperative condenser, as it were, the parallel, and preferably plane, metallic surfaces g, g^1, being the discharge surfaces which discharge through or across the intervening air dielectric. The air gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the discs are, the greater condenser capacity will they have, and hence the further apart they will spark.

At each discharge of the condenser a small portion of the plates g, g^1, is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two discs are completely oxidised. These discs may be made of copper or other suitable conductor material.

Suitable means is provided for accurately adjusting these plates relatively to each other and regulating their distance apart, or, in other words, for controlling the resistance of the intervening gaseous dielectric, and referring to the drawings, where

I have shewn a preferred means for accomplishing my object, it will be seen that I provide a plurality of posts g^2 threaded at their upper ends and carrying shouldered nuts g^3 on the shoulders of which is placed the top disc g^1.

The opposite plate g rests on a support or table g^4 and is mounted loosely on a post g^5, being normally held downwardly by a spring g^6 contained in a hanger or housing g^7 depending from the table g^4 said spring bearing at one end against the flanged lower end of the hanger g^7 and at its other end bearing against a washer g^8 retained by a screw g^9 whose head enters a hole or recess in the plate g for centering the latter.

The plate g is provided on its underside with a plurality of recesses or sockets, herein shewn as three in number, which receive props or struts g^{10} projecting upwardly from the base of the instrument.

These props g^{10} are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g^1.

The support g^4 has depending from its lower side a stud g^{11} which is engaged by the bifurcated end g^{12} of a lever g^{13} pivoted at g^{14} to a post g^{15} on its base.

By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other so as to incline the struts g^{10} more or less, and thereby increase or decrease the distance between the plates g, g^1, the nuts g^3 being depended upon for the coarser adjustments of the plates.

In Figs. 2 and 3 I have shewn the plates g, g^1, as hollow and provided with water circulation pipes g^{16}, in order that they may be absolutely prevented from all heating under extraordinary conditions.

Under usual conditions, however, this provision is entirely unnecessary, it being sufficient simply to provide the plates as shewn in Fig. 1.

When the adjacent surfaces of the plates have become entirely oxidized, the plates may be turned over and their opposite sides used, and when both sides have become oxidized, they may be readily removed and scoured off without destroying any of their adjustments.

My apparatus makes possible the sudden discharge of a condenser after the latter has reached a certain predetermined point, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations incapable of being obtained between a ball or point discharge gap.

The adjustment of the plates relatively to each other regulates the amperage discharge of the instrument being discharged.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A spark gap of the kind described, said spark gap presenting opposite parallel discharge surfaces of relatively large areas, and means for regulating the discharge distance between said parallel surfaces, substantially as described.

2. The herein described spark gap comprising opposite electrodes presenting parallel discharge surfaces, one of said electrodes being supported on three or more struts of equal length, and means for rotating said strut-supported electrode about its centre, whereby its adjustment may be varied to and from the opposite electrode, substantially as described.

3. A spark gap comprising two permanent large superficial areas parallel to each other, constituting opposite discharge surfaces, and an interposed gaseous dielectric, said discharge surfaces having condenser capacity for breaking down the intervening dielectric, and the latter automatically restoring or renewing itself, substantially as described.

4. A spark gap comprising opposite hollow plates or discs having parallel discharge surfaces, means for regulating the discharge distance between said surfaces, and

circulation pipes entering the same, whereby a circulation of water may be maintained for keeping the plates or discs cool, substantially as described.

5. A spark gap comprising three or more posts, shoulders adjustable thereon, a plate or disc supported on said shoulders, a second plate below the same, a support therefor, three or more upright struts loosely engaging said support, and means to rotate said support about its centre, whereby said struts are simultaneously and similarly moved for varying the distance apart of said plates, substantially as described.

6. A spark gap comprising a central post, a plurality of supporting posts, two plates, one carried by said supporting posts and the other adjacent said central post, three or more similar struts supporting said lower plate, a spring maintaining said struts in proper supporting relation, and means to rotate the lower plate on said central post, substantially as described.

7. A spark gap comprising a plurality of supporting posts, two plates, the lower plate being pivotally mounted, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

8. A spark gap comprising a central post, a plurality of supporting posts, two plates, the lower plate being pivotally mounted concentrically to said central post, a hanger depending adjacent said post, a spring between said post and hanger and engaging the hanging at its lower end and held by the post at its upper end, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

Dated the 14th day of March 1899.

WM. BROOKES & SON,
55 and 56, Chancery Lane, London, Agents for the Applicant.

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N° 12,408 A.D. 1901

Date of Application, 18th June, 1901—Accepted, 20th July, 1901

COMPLETE SPECIFICATION.

Improvements in and relating to Static Rectifiers and other Electrical Apparatus for Producing or Maintaining Continuous or Unidirectional Discharges

I THOMAS BURTON KINRAIDE, of 38 Spring Park Avenue, Boston, State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is shown as embodied in an electrical machine of the kind known as static rectifiers, but the invention considered in its broader features is not restricted to this particular electrical machine, but is of wide application to various kinds of electrical apparatus, and embodies certain important discoveries which I have made, whereby I am enabled to positively maintain an electrical discharge in one direction only, and under proper conditions to maintain said discharge continuously, producing, for instance, without the intervention of a commutator, a continuous current, directly from an alternating or intermittent current.

Without necessarily stating that such is the fact, it may be supposed that there is simply electrical energy and that the presence of said energy is what we call a positive condition, and the absence of said energy is what we call a negative condition, and this, taken with my discovery that electric energy in its positive condition discharges reluctantly from a plane (without edges, or angular or pointed surfaces) and discharges with perfect freedom from a point, enables me to control the direction of discharge of the current and hence the accumulation of potential.

The requisite conditions are provided by means of what I term an extensionless point which provides, as nearly as it can be done mechanically, the ideal discharge electrode or positive condition for the outward flow of the electrical energy, and by means of what I term a limitless plane which provides in the same manner the receptive electrode or negative condition in which there may be said to be an absence of energy (or a lower potential than that of the point from which the discharge comes), analogous to a vacuous condition or absence of electrical pressure.

By this means, the electrical energy tends to discharge continuously in one direction only, *viz*: from the extensionless point to the limitless plane.

I have applied my invention in various ways, as, for instance, in a static machine in which the receiving electrode has an extended plane surface or large flat area of the limitless plane type and the discharge electrode has a point discharge or preferably a series of points like a usual cone; but for the purposes of fuller explanation of my invention as well as being covered by certain of the claims in this application, I have illustrated my invention more elaborately in an electrical apparatus for producing unidirectional discharges of high potential.

In the drawings Fig 1 is a view, partly in perspective and largely diagrammatic, of one form of machine embodying my invention;

Fig 2 is a vertical cross-sectional view showing the most approved form of two of the cooperating electrodes;

Fig 3 illustrates the application thereof for transforming an intermittent current into a constant current;

[*Price 8d.*]

Fig. 1.

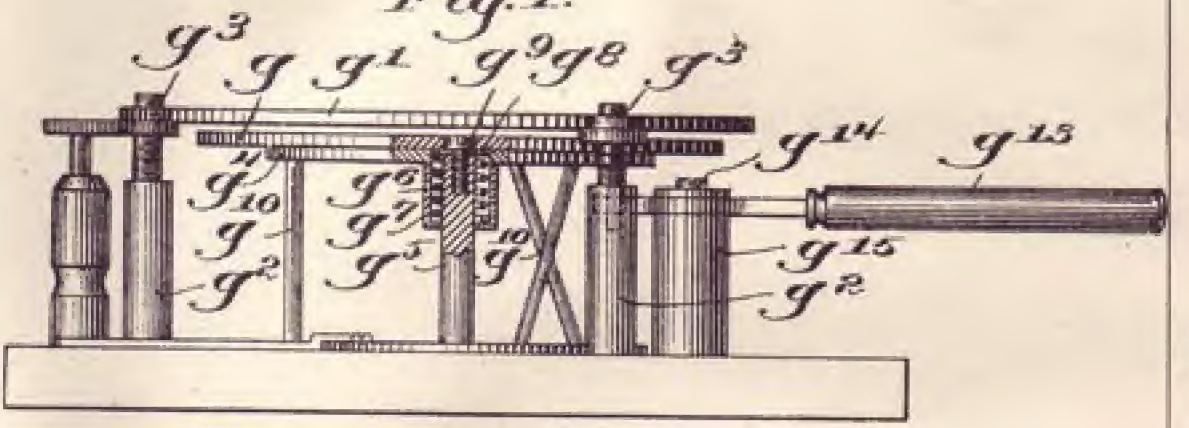


Fig. 3.

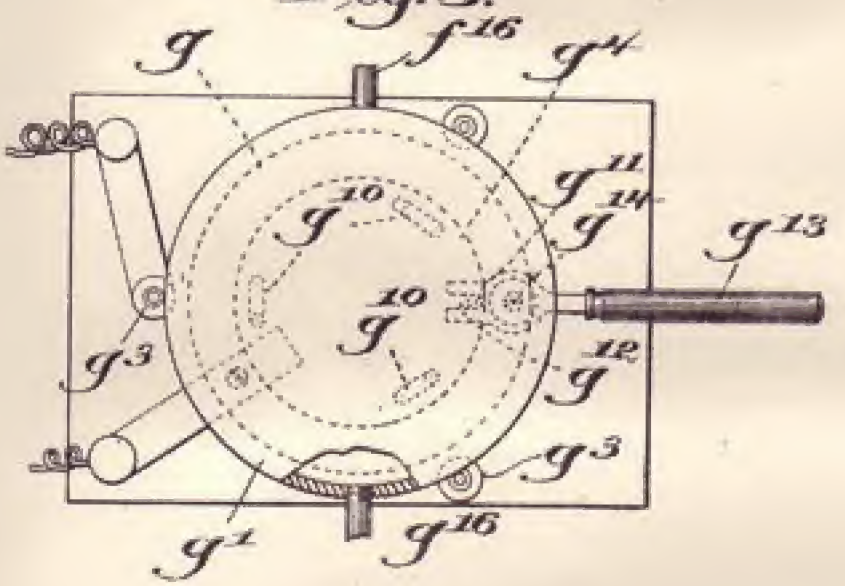
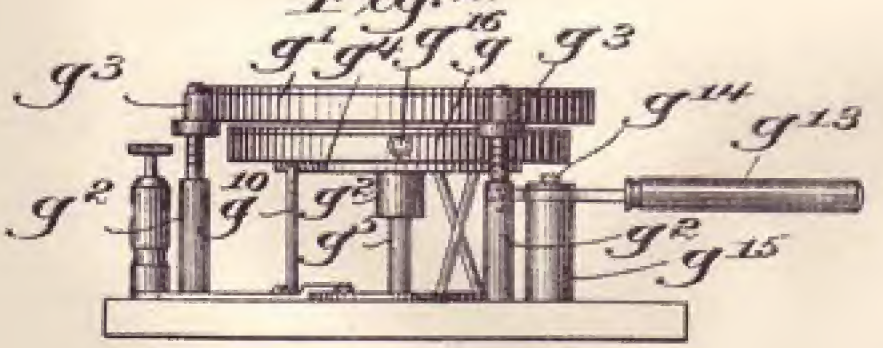


Fig. 2.



[This Drawing is a reproduction of the Original on a reduced scale.]

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Fig 4 illustrates the application of my invention to Leyden jars for converting an intermittent discharge into a continuous discharge.

Referring now more particularly to Fig 2, in order that the foundation idea of my invention may be first clearly understood, it will be seen that the electrode *a* is pointed or pencil shaped and that the extreme discharge point *b* is in or projected slightly through a small aperture *c* in a rubber or other flat disc *d* which extends at right angles thereto, the purpose of this disc being to cut off the attracting area which would otherwise be present in the converging walls or surfaces of the electrode *a*.

By this means I provide an extensionless point, speaking electrically. By this term, I mean a point in which the attractive area of the electrode relatively to the opposite electrode is limited to the point itself or, in other words, in which the rubber disc *d* shields all the surface of the rod or electrode behind the very point thereof.

The rubber disc constitutes means for cutting off the receptive area about the discharge point.

Opposite the electrode point *b* is the receptive electrode *e* which maintains a negative condition relatively to the electrode *a*, and which I have termed the limitless plane, speaking again electrically, this electrode having a large receptive area and being provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface or plane without angles or points, and this plane is secured by providing a flat surface *f* of considerable relative extent and curving its edges back and inwardly as indicated at *g*, whereby, viewed electrically, the surface is limitless inasmuch as it has no termination within the influence of the discharge point *b*.

In operation, the positive energy discharges invariably from the point *b* to the plane *f* and there is no discharge from the latter back to the point, one reason therefor being that the attraction of the limitless plane is compelling, there being practically no attraction in the opposite direction, due to the shielded point.

From the foregoing the extensionless point and limitless plane feature, which is at the basis of my invention, will be readily understood, and it will be seen that its field is important and large.

For example, in Fig 3 I have indicated a typical source of intermittent or alternating energy in the form of an induction coil *h* (operated by an alternating current) whose terminals *i*, *j*, are provided with electrodes *a*, *e*, of the kind already described, and opposite these electrodes which are arranged in pairs are complementary electrodes *e a*, connected to a working circuit *k* which it is desired shall have a continuous current.

Remembering that, as already explained, the extensionless point and limitless plane electrodes compel the discharge to take place in one direction, it will be seen that the intermittent or alternating discharge from the coil *h* is automatically transferred into a continuous current by the lower sets of electrodes as arranged in Fig 3.

Referring now to Fig 1, where I have shown a more complete machine constructed to employ my invention in an elaborate manner, I have mounted on suitable insulating posts 2 a series of these electrodes *a*, *e*, arranged in opposite sets, there being herein shown three pairs in each set, on opposite sides of the machine.

On the right hand side of the machine the point electrodes are mounted in a rail 3 and screened by a shield 4 (although they may be screened by any other suitable means, as may be convenient, and, in fact, the machine will operate to advantage for some purposes without any screen), and the plane electrodes are mounted in a conductor rod 5, while on the opposite side of the machine the arrangement is reversed, the plane electrodes *e* being mounted in the rail 3, and the point electrodes in the rod 5.

In a suitable position, herein shown as the end of the right hand rod 5, is

mounted a point electrode a^1, and opposite thereto mounted in the opposite rod 5 is a plane electrode c, while suitably connected thereto is any form of apparatus with which it may be desired to use the machine, herein shown as a condenser 6 connected by wires 7, 8, to the conductor rods 5.

On the base or table 9 are carried a plurality of high potential generating units, as they may be called, herein shown as usual induction coils 10, 12, 13, the terminals of whose secondaries are connected respectively to the lower set of electrodes immediately above them, as is clearly shown, and whose primaries are connected to a battery or other current source 14, an interrupter m being interposed in the circuit and a series of condensers 15, 16, 17, being properly interposed.

The condensers may be thrown into the circuit, as may be desired, by switches n, n^1, n^2.

While the machine will work with other forms of interrupters, yet for the best efficiency thereof I have found it necessary to employ a special interrupter consisting of a cup m^1 provided with a quantity of mercury m^2, above which is a bath of kerosene oil m^3.

A fixed conductor m^4 from the interrupter m leads into the mercury, and above the same is arranged a series of plungers or contact makers m^5, m^6, m^7, connecting respectively with the several high potential units 10, 12, 13, and operated by a shaft m^8 driven by any suitable means, as by a motor m^9, belt m^{10} and pulley m^{12}.

On the shaft m^8 are eccentrics m^{13} relatively adjustable by means of set screws m^{14}.

I have described my mechanism in all its preferred details of construction, as herein embodied, but it will be understood that many changes and substitutions may be resorted to without departing from the spirit and scope of my invention, and that the form and general make up of the apparatus will usually be modified to conform to the particular situation and purpose for which it is intended.

The operation is as follows When quantitative effect of discharge is desired, the interrupter is set as shown, the eccentrics all being placed the same, so that the coils are all broken simultaneously, the coils being in multiple, and thereby the lower electrodes a at the right hand, simultaneously discharge their respective coils, and this combined discharge is received by the opposite electrodes c and conveyed by the conductor 5, thereby giving an enormous discharge from the point a^1 to the receiving electrode c^1, the circuit being completed therefrom through the upper electrode a to the electrode c, and meanwhile the condenser 6 is charged, according to its capacity.

If, on the other hand, continuity of discharge is desired, the eccentrics m^{13} are adjusted in step with each other, so that the interruptions in the mercury cup are made dissimultaneously, or in succession, thereby discharging the coils 10, 12, 13, successively, and hence producing a continuous discharge between the electrodes a^1, c^1, this discharge being at a given voltage, according to the capacity of the condenser 15, 16, 17, or such part thereof as may be used.

By having a plurality of induction devices or high potential generators arranged in step in connection with the point and plane electrodes, I am enabled to obtain a continuous discharge, yet employ a slow interruption, the result being that a maximum output is made certain.

This result has not heretofore been feasible, as it would be necessary to operate the interrupter with great rapidity in order to get the high potential required, and when the interruptions of a coil are exceedingly rapid the output from the secondary, as is well known, is below its capacity.

This invention makes possible obtaining a purely direct discharge, *i.e.*, free from oscillations, such as has heretofore been obtained only from a static machine; accomplishes the handling or control of any quantity, however great, of high potential current; is a most powerful generator for X-ray work, and ideal in its control of the quality of X-rays, on account of the discharge being

wholly in one direction, continuous, and from a condenser; besides various other advantages which will occur to those skilled in the art.

In Fig 4 I have illustrated my electrode invention applied to two Leyden jars 18 having their outer coatings electrically connected by a wire 19 and their inner coatings connected by posts *p* in which are mounted usual discharge rods *r*, said posts, however, being provided on their upper extremities with the electrodes *a*, *c*: opposite to electrodes *c*, *a*, at the terminals of a coil *h* (operated by an interrupted current).

By this means, it is possible to maintain constant discharge at an approximately fixed potential similar to the discharge from a static machine, as the intermittent discharge from the induction coil which is the source of supply for the Leyden jars, is enabled to keep the Leyden jars at a practically saturated point, so that the latter can maintain a constant discharge between their rods *r*.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. The herein described means for producing a continuous or unidirectional discharge, consisting of electrodes one of which has a discharge point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge, as set forth.

2. An electrode terminating in a plane conducting surface, having its edges curved or rolled rearwardly and inwardly.

3. An electrode terminating in a comparatively fine point, and a flat shield extending approximately at right angles to said electrode and having a small aperture in which said point is located.

4. In an electrical apparatus, a source of intermittent electrical energy having at its opposite terminals electrodes one of which has a discharge point provided with means for cutting off the receptive area about said discharge point and the other of which has a large receptive area provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface without angles or points, and other electrodes cooperating with said terminal electrodes, there being a discharge point electrode arranged to cooperate with a receptive area electrode and *vice versa*.

5. An electrical apparatus, comprising a plurality of high potential generating units, and means uniting them in a unidirectional discharge.

6. An electrical apparatus, comprising a plurality of high potential generating units, means for giving them a unidirectional discharge, and mechanism for discharging them simultaneously or dissimultaneously, as desired.

7. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, and a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury

8. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury, and means for varying the movement of said contact makers with relation to each other.

9. An electrical apparatus comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup

having a series of movable contact makers movable in oil above said mercury, said condenser having a plurality of independent parts, and switching mechanism for throwing said parts independently into the circuit of said primaries.

Dated the 18th day of June 1901.

5

WM. BROOKES & SON
55 & 56 Chancery Lane London
Agents for the Applicant

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Fig. h.

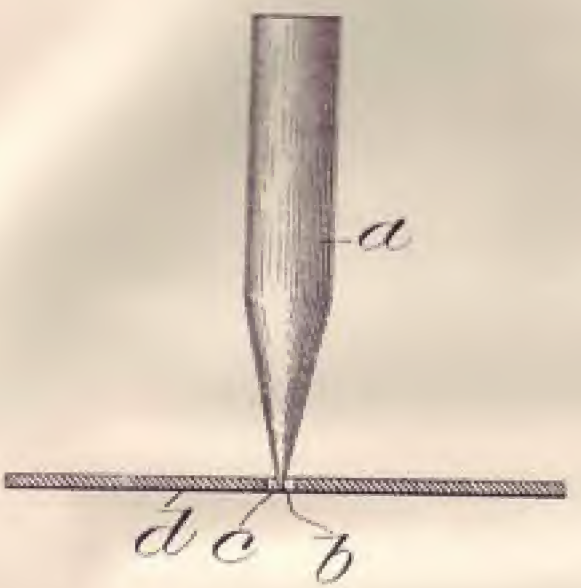

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Fig. 1.

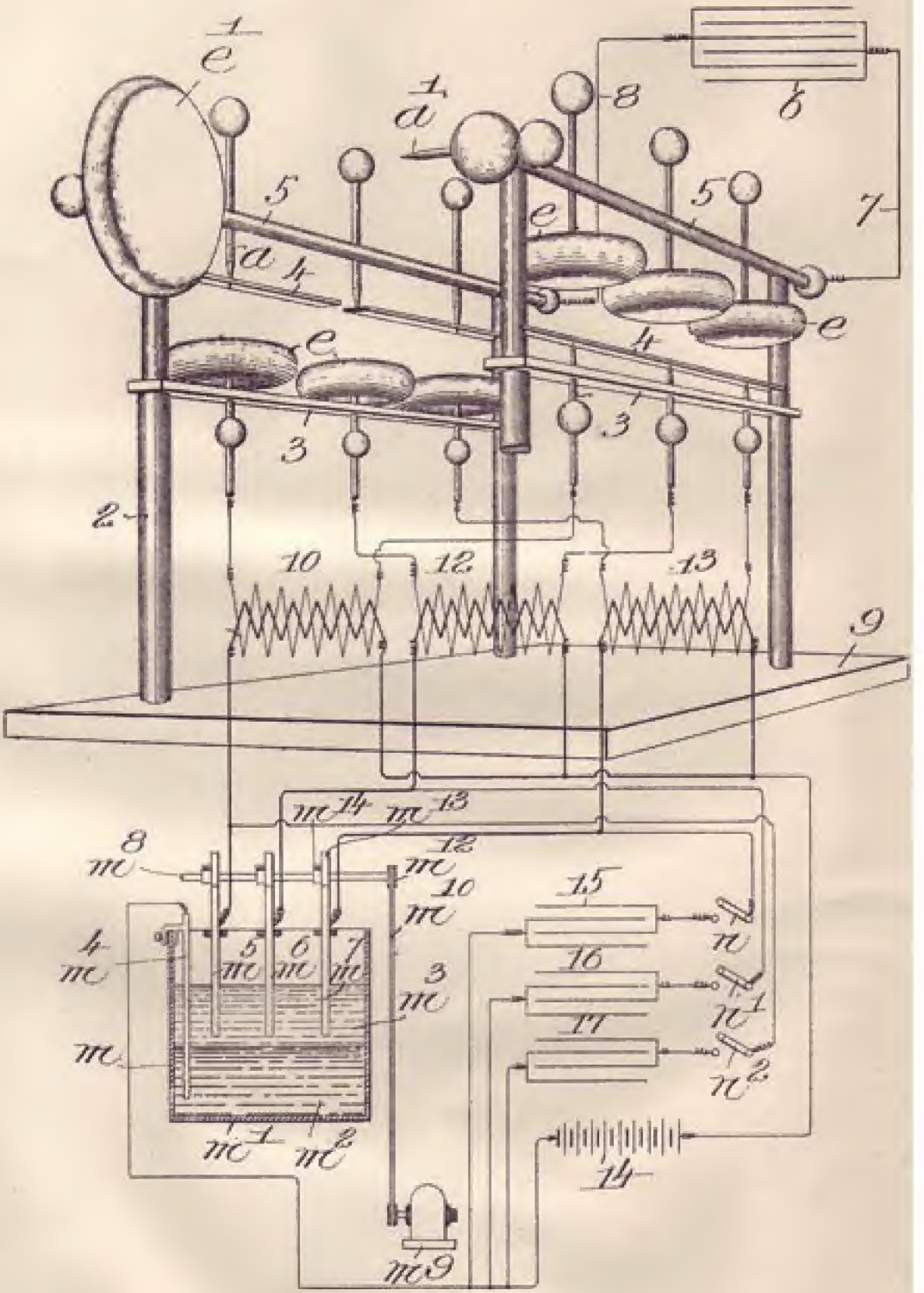
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Fig. 3.

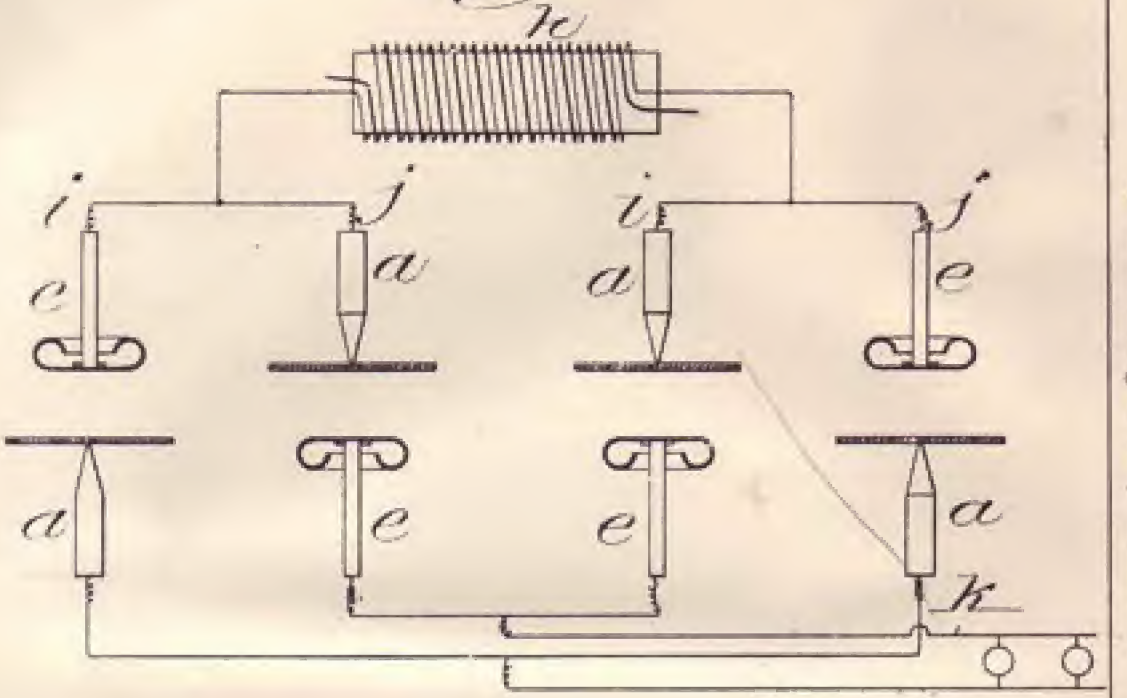
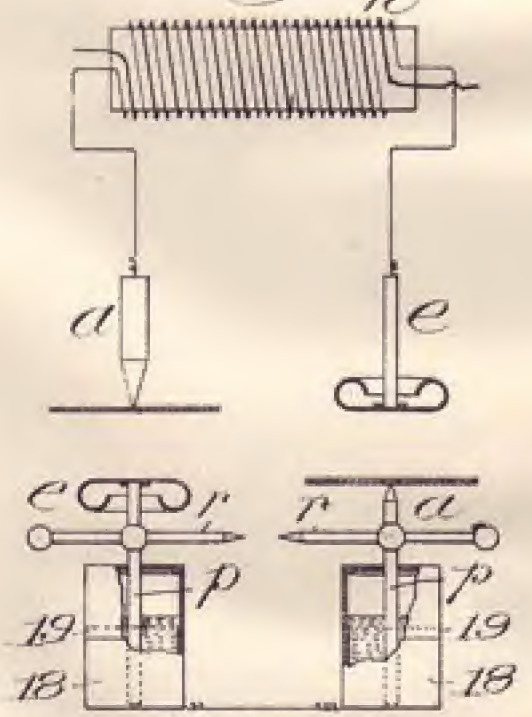


Fig. 4.



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No. 615,652. Patented Dec. 6, 1898.

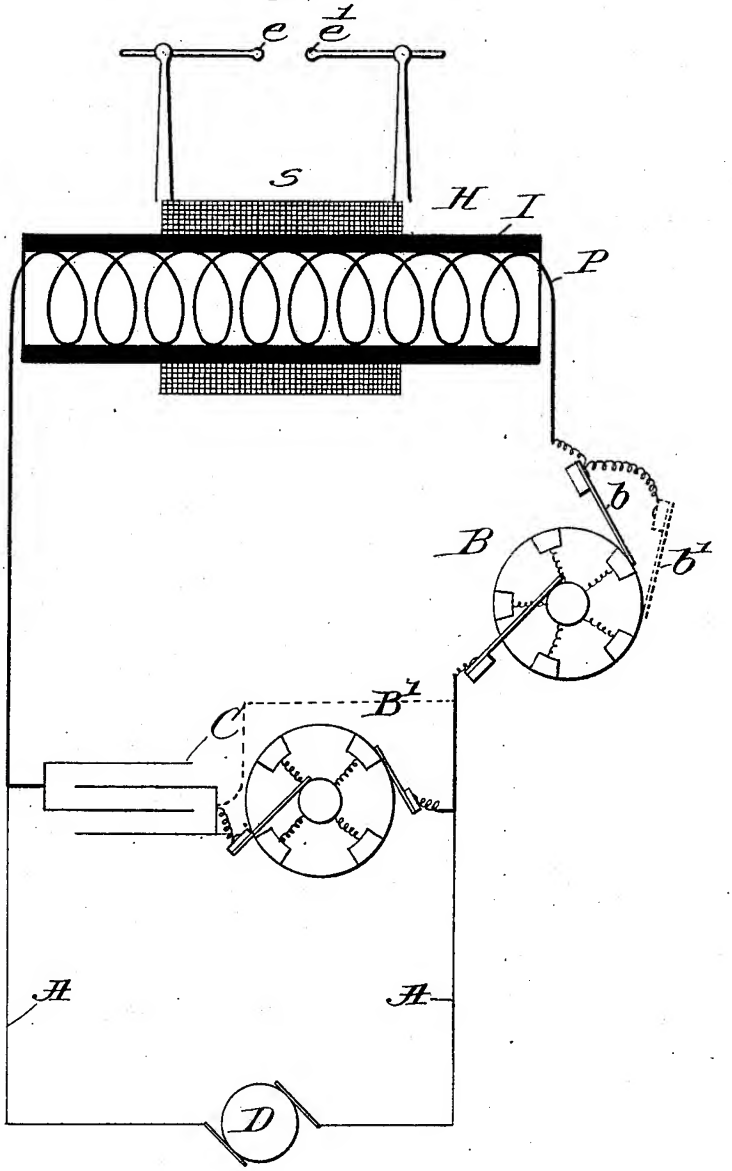
T. B. KINRAIDE.

HIGH FREQUENCY APPARATUS.

(Application filed May 13, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.



Witnesses:
Fred S. Grundy
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Inventor:
Thomas B. Kinraide.
By Lorosby & Gregory
Attys.

No. 615,652. Patented Dec. 6, 1898.

T. B. KINRAIDE.

HIGH FREQUENCY APPARATUS.

(Application filed May 13, 1897.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

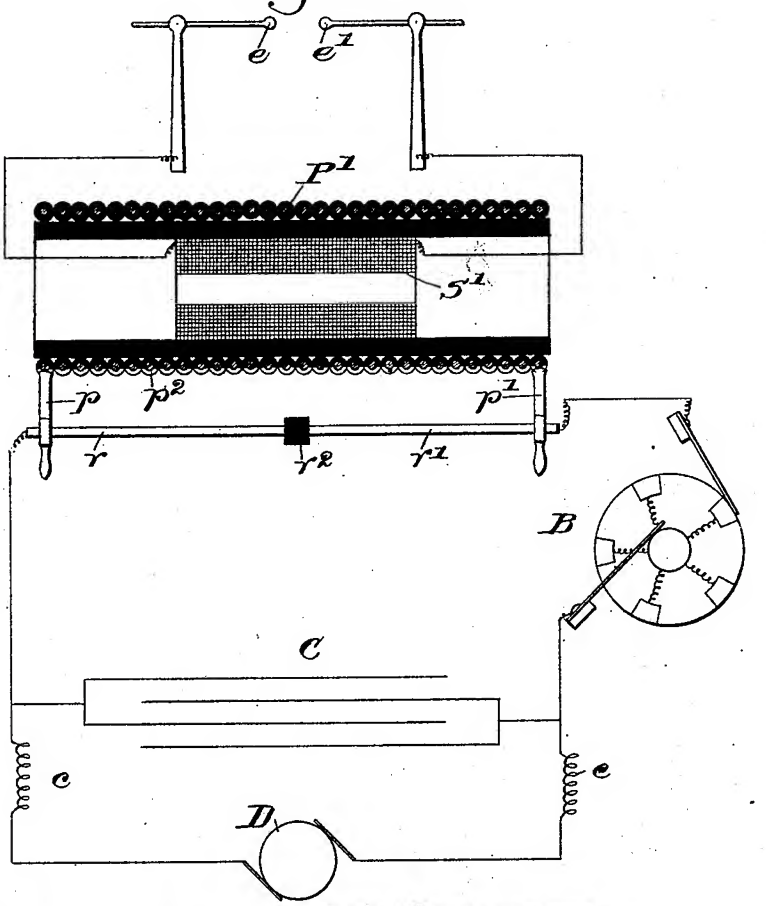
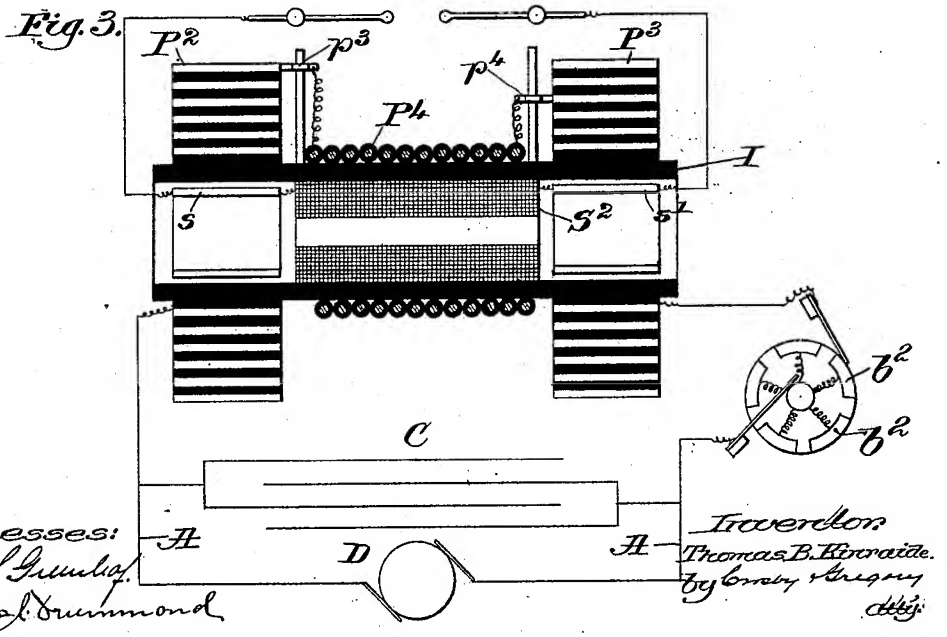


Fig. 3.



Witnesses:
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Thomas L. Drummond

Inventor:
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by Cooley & Gregory
Atty's.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-FREQUENCY APPARATUS.

SPECIFICATION forming part of Letters Patent No. 615,652, dated December 6, 1898.

Application filed May 13, 1897. Serial No. 636,293. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in High-Frequency Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to oscillators or high-frequency coils, having for its object the provision of compact apparatus of enormous rapidity and comparatively light weight and bulk especially adapted for work with X-rays.

The details of my apparatus will be more fully apprehended in the course of the following description, taken in connection with the accompanying drawings, illustrative thereof, and the invention will be more fully defined in the appended claims, forming a part of this specification.

In the drawings, Figure 1 shows diagrammatically one embodiment of a simple form of apparatus for carrying out my invention. Figs. 2 and 3 are similar views showing further features of the invention.

A A designate a circuit from a suitable source of electricity, herein shown as a dynamo D, this circuit being any usual commercial circuit or branch from a usual street-main or any other source of energy and leads directly, without any intervening apparatus, to a condenser C of small capacity.

The condenser is connected at either end (the right-hand connection being indicated by dotted lines, Fig. 1) to a coarse primary P, preferably having a single winding of a high-frequency coil H, a break B being interposed in the circuit, this break being shown as a commutator, although any other high-speed interrupter may be employed.

From the above description it will be understood that the dynamo is in direct circuit with the condenser, giving the latter a continuous primary charge, which is constantly piled up in the condenser; but the relatively coarse wires of the coil-circuit, the circuit being completed with great rapidity by the high-speed break, tend constantly to discharge the condenser, and this is accomplished and without any excessive raising of the potential thereby, so that the potential of the coil depends almost altogether upon the fluctuations of the condenser for its intensity.

The fluctuations in the oscillator or coil are exceedingly high, for the reason that the break is run at a very high speed and the secondary is tuned thereto, being of relatively few turns, as already stated, the result being that there is a very powerful sparking from the electrodes e e', and yet the potential of the coil is not so high as in the oscillators at present employed, and therefore no oil insulation is required. This is a great desideratum in this apparatus, for the reason that the oil insulation has proved a very serious obstacle in practice.

In order to increase the efficiency of the apparatus still more, I prefer to construct the break or otherwise provide it with means whereby the intervals between the interruptions thereof may be proportioned to the time-constant of the circuit, and for this purpose I have indicated in dotted lines in Fig. 1 an adjustable brush b', movable relatively to what I may term the "main" brush b, (shown in full lines,) these brushes being adjusted so that the two brushes shall both rest together on an insulation before the contact is again completed, the periods of contact between said interruptions being readily proportioned, as stated, by this means, so as to correspond to the time-constant of the circuit, or instead of the adjustable means shown in Fig. 1 and just described I may build the commutator, if that kind of interrupter be used, so that it shall be definitely proportioned originally as desired, this construction being indicated in Fig. 3, where the contact-segments b^2 are shown as having considerable peripheral area, so as to increase the period of contact of the brush to correspond to the time period of the circuit. This feature of my invention produces greatly-improved results in the oscillatory discharge of the coil.

Another improvement resides in providing an additional break B' at that end of the condenser which is adjacent the other break B, but not so as to cut off the circuit A from the latter break. I have indicated this break in Fig. 1. In this construction the breaks will be so constructed that certain of their interruptions will be substantially in unison and certain other of their interruptions will be

out of unison—that is to say, if the breaks are both rotated on and by the same shaft or otherwise caused to rotate in synchronism.

The break B may have, for instance, thirty contact-segments and the break B′ may have twenty contact-segments, so that as a result there will be in one revolution ten interruptions in unison and ten times when the two breaks will be half an interval apart and ten times when they will be a whole interval apart. Any other arrangement for producing this effect may be substituted. One break may have fifteen segments and the other twenty, &c.

The effect of the above-outlined construction is that the coil is given great frequency, and when the complete construction, as indicated, Fig. 1, is employed extraordinary results may be produced by causing the proportioning and arranging of the parts to be such that a spark-gap shall be maintained in the break B with an approximately continuous discharge, the break B operating in its revolutions to increase and decrease this spark-gap and the break B′ interrupting the same by intermittingly connecting the condenser into the circuit thereof, so that the operation of the oscillator is brought down from the usual singing sound to a sharp decisive snap and the sparking thereof is changed from the usual bluish sparking to a series of white sparks. Indeed, for certain laboratory purposes a copper disk may be substituted for the break B, which being rapidly rotated will cause by reason of the slight unevenness of its surface and of the frictional contact of the brush therewith a pulsation or interruptive tendency in its circuit, producing to some extent a similar effect to that of the break B.

The primary P may be either inside or outside the secondary S, being insulated therefrom at I, and the coil may have a core, although I prefer to use it without a core.

In Fig. 2 I have shown the primary P′ outside of the secondary S′ and have shown means for adjusting the coil so as to perfectly balance the fluctuations thereof and produce the precise harmonic effect desired for the purposes of any particular use thereof—as, for instance, the study of striæ, &c.—this means consisting of two brushes p p', sliding back and forth by any suitable means, being shown as mounted on conductor-rods r r', insulated from each other at r^2, the insulation of the primary being grooved to form a contact-path p^2, along which the brushes may move in contact with the successive turns of the coil.

From the above description it will be evident that the sparking between the electrodes e e' may be varied, so as to get any kind of discharge desired, it being possible to move the brushes p p' together toward each other, so as to decrease the area of the primary evenly relatively to each end of the secondary, or to move one brush independently of the other, and thereby increase or decrease the relative area of the primary at one or the other end of the secondary, it being worthy of observation also that the portion of the primary which is cut out, or that is left remote from the secondary beyond the brush, is not cut out entirely, so as to be of no effect; but it has an appreciable effect in influencing the action of the coil, the latter being, however, more readily seen in connection with the apparatus shown in Fig. 3, to which reference will now be made.

I have shown a primary in Fig. 3 external to the secondary S^2 and made up of two separated portions P^2 P^3 adjacent the respective ends of the oscillator, each of these portions being made up of a flat helix of flat conductor, such as a copper ribbon, properly insulating from itself, as indicated, brushes p^3 p^4 being preferably provided movable up and down to contact with the successive layers of each helix, as shown, for the same purpose as already described in connection with the movable brushes of Fig. 2, the primary having an intermediate portion P^4 to give direction to the fluctuation. The secondary has preferably end pieces s s', which may be of copper or other conductor, being preferably ribbons of tin-foil secured to the inner surface of the insulation I, these extended areas of the secondary being in the direct field of influence of the portions P^2 P^3 of the primary. The operation and advantage of this construction is that it adds capacity to the high-frequency coils, so that a bright spark and heavy discharge takes place instead of the more disruptive discharge heretofore. The end portions of large area of the secondary give a condenser action to the secondary, tending to store or accumulate potential and produce much heavier and more sudden discharges with greater drop than would take place if the secondary terminated in the fine wire itself merely.

While I have described above my new method of operating an oscillator or high-frequency coil, I may remark that particularly in connection with the form of apparatus shown in Figs. 2 and 3 one or more choke-coils c (see Fig. 2) may be used in order to raise the potential.

The apparatus already described is of peculiar advantage for use in the observation of vacuum-tube discharges and the study of striæ, it being necessary in such matters to be able instantly and delicately to change the conditions of observation, the operator judging thereof by the appearance of the phenomena. For instance, if the striæ are confused and indistinct it is necessary to bring the coil into tune or at least into different tune from its condition, whatever the latter may be, and it is not always feasible and it may be, in fact, impossible to get the desired results by changing the speed of the break or the charging of the condenser or the capacity of the latter, &c., so that these observations are rendered extremely difficult and unscientific.

By the adjustable feature of my invention shown in Figs. 2 and 3 the coil may be instantly and accurately adjusted, so as to bring out the striæ distinct and clear. Again, still taking the study of striæ as an illustration, it frequently happens that the latter will constantly rush toward one end of the tube or will separate at the opposite ends thereof and will waver, so that they may not be readily studied or so that they may not be photographed, for instance. My invention enables the operator at once to throw the coil into such perfect balance that he may cause the striæ to remain perfectly stationary as desired simply by moving the brush p or p' outwardly at the end of the coil which proves to be the weaker, thereby bringing the influence of a higher potential to bear upon that end of the coil or by oppositely moving the other brush to lower the potential at the stronger end of the coil.

While I have herein shown a preferred embodiment of my invention I wish it understood that I am not restricted thereto, but that various changes in details and rearrangements of the combinations of parts may be resorted to within the spirit and scope of my invention as defined by the claims.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an induction device provided with a primary having a plurality of turns, means to shift the circuit connection from one turn to another transversely of said turns, at either or both ends of the coil at will, substantially as described.

2. The combination with a relatively immovable primary and a secondary of an induction device, of means to vary the position of the field of said primary relatively to the secondary by increasing said field at one end of the secondary and decreasing it at the other end, or vice versa, substantially as described.

3. The combination with a primary and a secondary of an induction device, of means to bring a greater or less number of turns of the primary into direct inductive action on the secondary independently at either end thereof, substantially as described.

4. The combination with a primary, of a secondary having opposite end portions of large area, substantially as described.

5. The combination with a primary, of a secondary, said secondary having opposite end portions of large area, and said primary also having relatively large area opposite thereto, substantially as described.

6. In an induction device, a primary having end portions of low resistance and extended area, substantially as described.

7. In an induction device, a primary having end portions of low resistance and extended area, said portions consisting of ribbon-like flat coils, substantially as described.

8. In an electrical apparatus, a source of energy, a primary, and a break in series circuit, and a condenser and second break in parallel across said source of energy, said second break being interposed at that end of the condenser adjacent said other break, said two breaks being constructed to give certain interruptions substantially in unison, and certain other interruptions out of unison, substantially as described.

9. In an electrical apparatus, a source of energy, a primary, and a break in series circuit, and a condenser and second break in parallel across said source of energy, said second break being interposed at that end of the condenser adjacent said other break, said two breaks being constructed to give certain interruptions substantially in unison, and certain other interruptions out of unison, and said first-mentioned break having the intervals between its interruptions proportioned to the time-constant of the circuit, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
GEO. W. GREGORY.

No. 615,653. Patented Dec. 6, 1898.

T. B. KINRAIDE.

HIGH FREQUENCY INDUCTION APPARATUS.

(Application filed Mar. 4, 1898.)

(No Model.)

Fig. 1

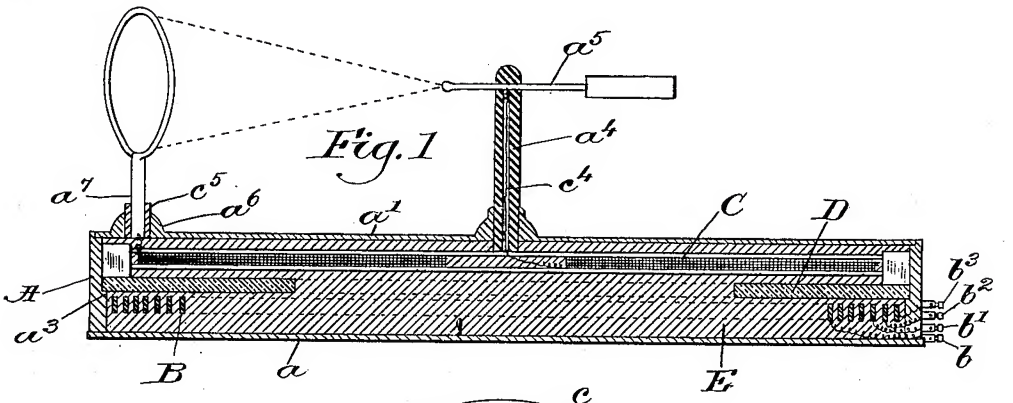


Fig. 2

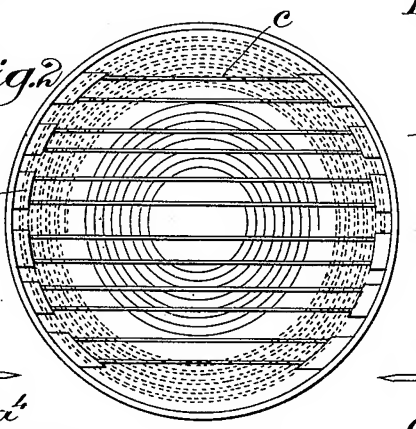


Fig. 3

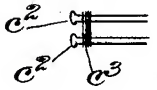


Fig. 4

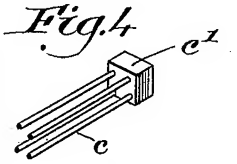


Fig. 5

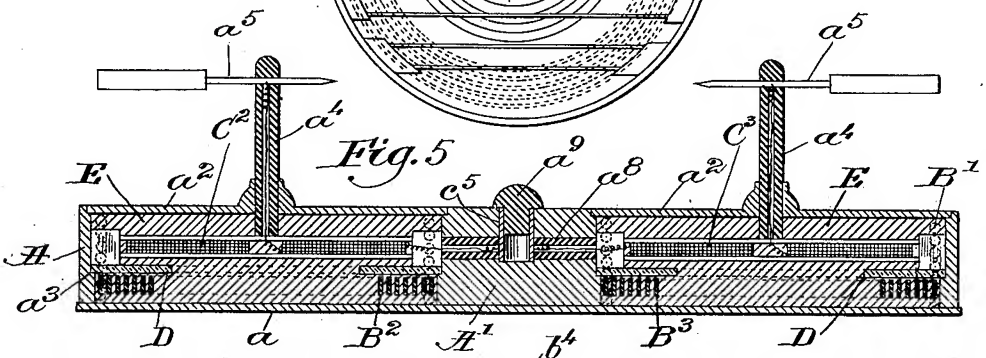
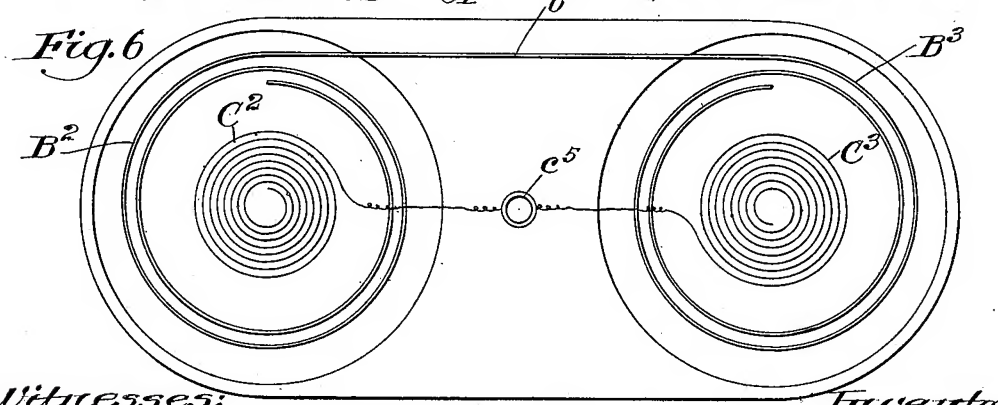
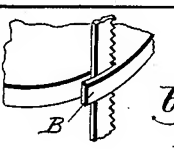


Fig. 6



Witnesses:
A. C. Harwood.
Walter E. Lombard.

Fig. 7.



Inventor.
Thomas B. Kinraide
by Crosby Gregory & Phillips.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-FREQUENCY INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 615,653, dated December 6, 1898.

Application filed March 4, 1898. Serial No. 672,531. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in High-Frequency Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an improvement in induction-coils, and has for its principal object the provision of an apparatus capable of unlimited high frequency without danger of self-destruction or breaking down.

Induction-coils as ordinarily constructed are wound in disk form, the disks being placed side by side, usually in a columnar or tubular form over a central core, so that of course the coils are shortest, and hence offer least resistance, at the centers of the disks or next the core, and the highest potential is at the outside—*i. e.*, at the circumference of the disk—where the coils are the longest. I have departed entirely from this principle and have produced a flat coil in which the highest voltage is at the shortest turns and the lowest voltage is at the longest turns, or, in other words, the voltage increases inversely as the resistance.

In its simplest form and preferred embodiment my invention comprises a coarse primary of few turns and a fine secondary of many turns, preferably coaxially arranged, and the primary being confined to the low voltage or circumferential portion of the secondary.

The details of construction and the more complete embodiment of my invention and the more striking phenomena thereof will be set forth in the course of the following description, reference being had to the accompanying drawings, and the invention will be more particularly defined in the appended claims.

In the drawings, in which I have shown preferred embodiments of my invention, Figure 1 is a central vertical section of a simple coil or apparatus, illustrating one form of my invention. Fig. 2 is a top plan view thereof, on a reduced scale and partly diagrammatic, in order to give a clear understanding thereof. Figs. 3 and 4 are perspective details of insulators or separators employed. Fig. 5 is a view similar to Fig. 1, showing a complete embodiment of my invention. Fig. 6 is a top plan view thereof, partly diagrammatic. Fig. 7 is a fragmentary view showing one way of making the coarse primary.

In a box A of any suitable shape and size desired, being herein shown in Figs. 1 and 2 as circular and in Figs. 5 and 6 as oblong with rounded ends, I mount a primary B and a secondary C, a partition D, preferably of glass, being interposed between the primary and secondary, if desired, although it may be omitted. The box A has preferably a removable bottom *a* and top *a'*, Fig. 5, these parts being preferably constructed of vulcanite or other insulating material.

When a partition D is employed, a ledge a^3 may be molded, stamped, or turned, if desired, on the inner wall of the box, on which the partition may be seated, and for neatness of construction the top also will preferably rest on a similar ledge. The top and bottom may be screwed or otherwise secured to the edges of the walls or rim of the box, although I wish it understood that the details of the inclosing box may be infinitely varied within my invention.

I wind the secondary C, of fine wire and such area as is desired, in the form of a thin flat disk and secure it by suitable means in one of the sides of the box, herein shown as the upper side, the securing means being herein shown as comprising a plurality of glass rods *c*, arranged in pairs oppositely placed above and below the secondary and together constituting a holding-grid. It is obvious that this grid may be made in any form, the parallel bars being preferred merely for convenience. Having properly positioned the secondary between its holding-rods *c* or such other holding devices as may be used, I preferably connect the terminals of the secondary with a current sufficient to raise the secondary to a considerable heat and then pour into the box a melted insulating compound E, preferably of rosin and beeswax, sufficient to fill the box and entirely cover the secondary, preferably also covering the holding-rods *c*, as is indicated in the figures, maintaining the heat for a sufficient time to insure that the melted rosin and wax shall have permeated into every in-

terstice of the secondary and its neighboring parts. The primary is put in position in the same manner, excepting that no holding-grid is necessary therefor, inasmuch as the inherent rigidity of the coarse wires prevents any buckling or warping thereof under the action of the heated insulating compound. The result is that when the insulating compound has hardened the primary and the thin flat disk of the secondary are insulated absolutely.

In view of the fact that my secondary is made of such fine wire and in the form of a thin disk it is necessary that it should be positively held by a grid-like holder while the wax is being poured, as otherwise it would work out of shape.

The rods *c* may be held at their ends by glass blocks *c'*, as shown in Fig. 4, or a more convenient construction is that shown in Fig. 3, where it will be seen that the rods are severally provided with heads c^2 and are tied together simply by wrapping a piece of silk thread c^3 around the ends thereof. This latter construction is extremely convenient. These glass rods, it may be remarked, are also advantageous for holding thin or fragile conductors in various other relations than that herein shown.

It will be observed that the partition D is cut away at its middle portion, so that it will be understood that both sides, or, in other words, the entire apparatus, is poured at once with the insulating compound. The compound which I have mentioned is normally solid, and therefore there is no tendency in the apparatus to leak; but, on the contrary, it is substantially one piece or solid, without any danger of loosening or getting injured. Moreover, if from any cause whatever any heating effects have been produced at any point in the apparatus, it is evident that the fusible insulating compound would be softened or melted sufficiently to cause it automatically to flow around the heated portions and maintain perfect insulation.

I prefer to employ a primary made as illustrated in full lines in the figures, where it will be seen that it consists of a flat helix of coarse wire or metal, although it may be in other forms—for instance, as indicated in dotted lines at B' in Fig. 5. This helix B is conveniently made by sawing a piece of sheet metal to produce the form shown, (see Fig. 7,) the air-gap formed by the saw-cuts being sufficient in practice to insulate the primary, especially when embedded in the insulating compound, as explained.

I have shown both primary and secondary as circular, although it will be understood that they may be square, oval, or any other shape desired—oval, for instance, being preferable where it is desired to get a long spark-gap in an instrument of the form shown in Fig. 1.

In the above description I have purposely omitted all technical details of construction in order to present my invention in its broad features and in its simplicity, although it will be understood that proper binding-posts and connections will be provided, as indicated at b^2 b^3, Fig. 1, and that the other usual features of regulation will be used in connection therewith, including a break, condenser, &c. The inner terminal of the secondary is shown at c^4 as extending in a central post a^4 to a usual adjustable electrode a^5, and the opposite terminal of the secondary is shown in Fig. 1 as terminating at a thimble or ferrule c^5 in a socket a^6, which may contain any suitable electrode, a ring-discharger a^7 being shown in place therein.

Referring to Figs. 5 and 6, it will be seen that I have provided two primaries B^2 B^3, connected together at b^4, and two secondaries C^2 C^3, electrically connected by a contact ring or ferrule c^5 similar to that already described. The two primaries and secondaries are separated by an insulating-block A', which constitutes a portion of the box, and they are embedded in insulating compound precisely the same as described in the simpler form of the apparatus shown in Fig. 1, it being understood that the connecting-wires of the primary and secondary are carried through insulating-tubes, as is indicated at a^8, Fig. 5. The inner terminal of each of the secondaries C^2 C^3 connects with a central post a^4, containing an electrode a^5, as already described, and the thimble or ferrule c^5 (shown in Fig. 5 as stopped by a plug a^9) is adapted to receive a discharge-ring a^7 or any other form of electrode, although usually it will be stopped by the plug, as shown. The primary is restricted to the circumferential portion of the secondary—that is to say, it is located in the vicinity of the outer or larger turns of the secondary in the form of an annulus having a large central aperture. Besides this, I make the primary relatively short and of large cross-sectional area, the latter feature giving the primary large condenser or static capacity. Also there is an entire absence of any core or anything of that nature to produce sluggishness. The result is that I am enabled to obtain exceedingly high frequency without destructive heating.

The primary being entirely or mainly located at one side of or adjacent the circumferential portion of the secondary and there being no core of magnetic material, but only electrical inductive action, there results a piling up or condensing of the lines of force at the center of the secondary in an obvious vertical form, so that the potential or voltage of the inner portion of the coil is high and of the outer portion low. The intensity of the electrical field is enormously increased at the center of the coils and nearly all the lines of force of the entire coil are concentrated upon this central portion thereof, and the construction is such that this condition is maintained—that is to say, there is an enormous propulsive discharge from the electrode at the center of the coil and there is

scarcely any discharge from the outer electrode thereof at c^5. This will be understood by referring to Fig. 1, where I have indicated by dotted lines the discharge effects. The discharge takes place or may take place like radiant flames collected by a ring, as shown in Fig. 1, or by removing the ring or turning the electrode a^5 at some other angle this radiant discharge simply shoots out into space.

One great advantage besides that already pointed out of the high frequency and enormous discharge is that there is no fear of melting down the coil. Heretofore in induction-coils it has been necessary to exercise extreme care in regulating the discharge-terminals so as to prevent too great resistance between them, as otherwise the apparatus would at once short-circuit itself and quickly be ruined, whereas in my present invention all this is done away with.

While I have herein described a preferred embodiment of my invention, I wish it understood that very many changes and rearrangements may be resorted to without departing from the spirit and scope of the invention and that I am not limited otherwise to details than as expressed in the appended claims.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An induction device, comprising a secondary in the form of a flat coil, and a primary in the form of a flat coil, superimposed flatwise and coaxially one on the other, said primary being in the form of an annulus having a large central aperture relatively to the said coaxial secondary, as and for the purpose set forth.

2. An induction apparatus comprising a winding producing an exciting-field, and an electric conductor excited thereby, said conductor having a plurality of turns of varying lengths, said field-winding being located adjacent the longer of said turns, and the shortest of said turns having the highest voltage, substantially as described.

3. An induction apparatus comprising an electric conductor whose resistance per turn diminishes as its voltage increases, and an exciting-field winding adjacent and confined to the low-voltage portion of said conductor, substantially as described.

4. In an induction apparatus, a plurality of turns of electric conductor, said conductor being constructed and wound to present decrease of resistance in the turns toward one end with an increase of voltage toward the same end when under the influence of current, and means to maintain said high voltage at said end of minimum resistance per turn, substantially as described.

5. An induction device having a primary of sheet metal, the turns of said primary being insulated from each other by a saw-cut, substantially as described.

6. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and the bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, substantially as described.

7. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, said secondary being retained from warping by means of an insulating-grid comprising bars extending across it both above and below, substantially as described.

8. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a secondary for each primary, said primaries and secondaries being constructed and arranged to maintain high voltage at the center of each secondary, and low voltage at the circumferential terminals thereof, the inner terminal of one of said secondaries being positive and the inner terminal of the adjacent secondary being negative, substantially as described.

9. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a separate secondary for each primary, said secondaries having regions of high voltage at their centers, and regions of low voltage at their circumferential terminals when the apparatus is in action, substantially as described.

10. An induction apparatus comprising a plurality of primaries connected together, and a secondary for each primary, said secondaries being respectively located substantially coaxially relatively to their primaries, and each being wholly or mainly within the primary, the latter being adjacent the circumferential portion of the secondary only, whereby a large propulsive discharge may be maintained at the central terminal of the secondary with an inappreciable discharge at the circumferential terminal thereof, substantially as described.

11. An induction apparatus comprising a

plurality of coarse, short, flat-coiled primaries connected together, and a corresponding plurality of long, fine secondaries wound in the form of flat coils, each primary being wound with a large central aperture, and having its coils restricted to the area adjacent the longer of the turns of its secondary, substantially as described.

12. An induction apparatus comprising a shallow box having a plurality of compartments and removable tops therefor, each compartment containing a coil constituting a primary, and a second coil constituting a secondary, said coils being coaxial with each other and the secondary extending within the primary, said coils being embedded in a fusible insulating substance normally solid and filling said several compartments, said box having insulated passages connecting said boxes, and said several primaries having one of their terminals communicating through said passages, and a discharge post or device for the central terminal of each secondary, substantially as described.

13. An induction device comprising a shallow box having a closed bottom, a flat coil of a single thickness of wire adjacent said bottom and confined adjacent the walls of the box, and a flat coil constituting a secondary winding contained in the box adjacent the other winding and extending approximately to the center of the box, said secondary winding being retained from warping by means of a plurality of glass bars arranged transversely thereof on opposite sides of the winding, the box being filled with and said primary and secondary being embedded in a fusible insulating substance normally solid, substantially as described.

14. An insulating-grid adapted to bind together and insulate a disk or other winding, said grid being composed of glass bars arranged opposite to each other on opposite sides of the winding and projecting therebeyond at their ends, said ends having heads adapted to be bound together by a filament, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

ALEXANDER C. PROUDFIT.

No. 619,760. Patented Feb. 21, 1899.

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1

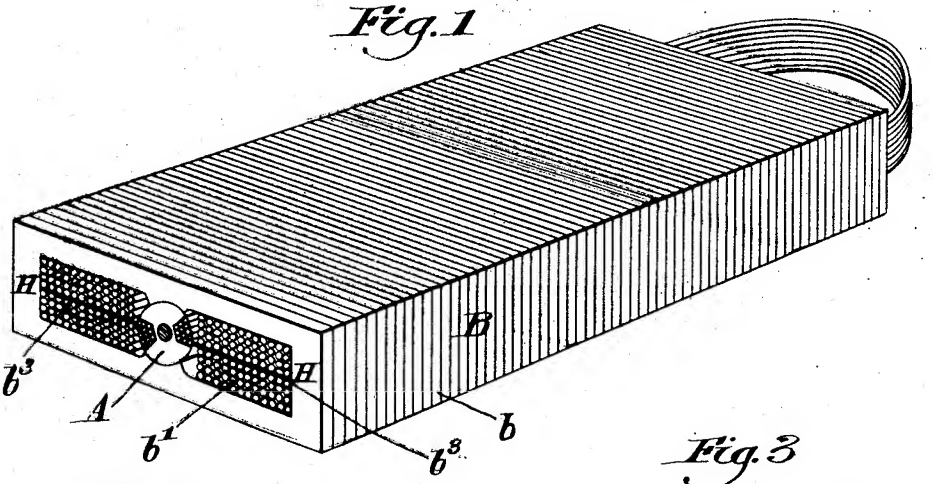


Fig. 2.

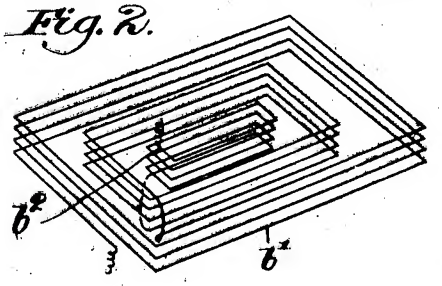


Fig. 3

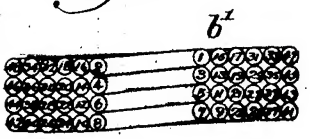


Fig. 4.

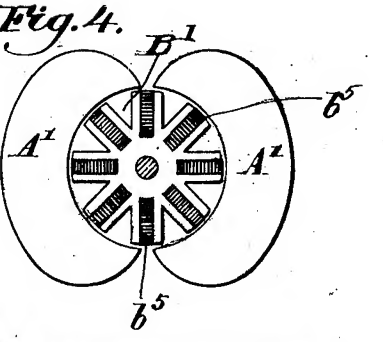
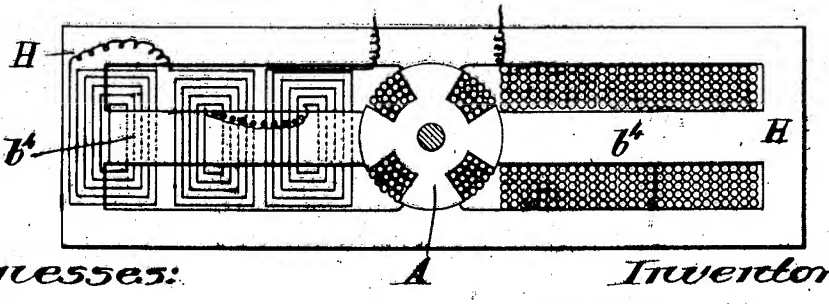


Fig. 5.



Witnesses:

A. C. Harwood

Fred. L. Grumbach

Inventor:

Thomas B. Kinraide

by Crosby & Gregory

attys

No. 619,760. Patented Feb. 21, 1899.

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 6.

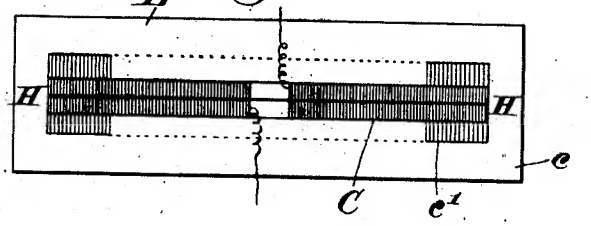


Fig. 7

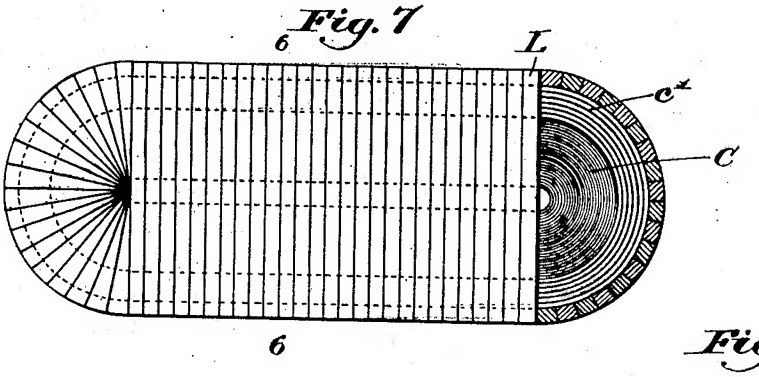


Fig. 9

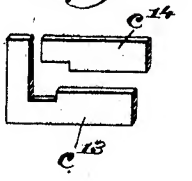


Fig. 8

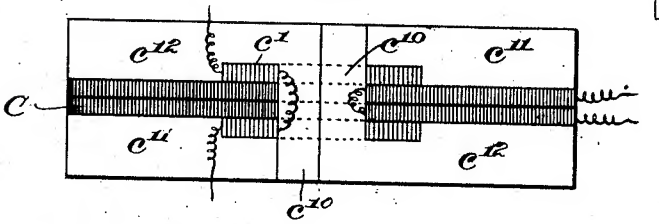


Fig. 10.

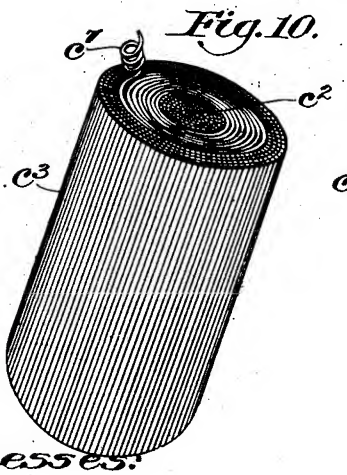
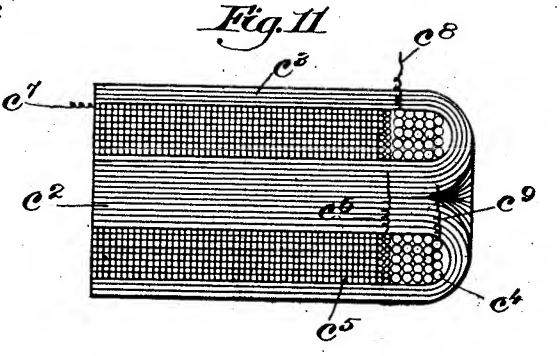


Fig. 11



Witnesses:

A. C. Harwood

Fred. S. Grinnell

Inventor:

Thomas B. Kinraide

by Crosby & Gregory

attys.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 619,760, dated February 21, 1899.

Application filed May 5, 1898. Serial No. 679,800. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Dynamos, &c., of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

My invention aims to accomplish an increased efficiency in electrical apparatus by means of a new winding thereof, which I have discovered to be the only proper winding for taking advantage of the natural impedance and inductance, so as to give a proper rise of potential in the direction desired only.

I have illustrated my invention in several different forms of apparatus in order that it might be fully apprehended, and the details of these devices will be more fully understood from the following description, reference being had to the accompanying drawings, and the invention will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a perspective view, partly diagrammatic, illustrating one manner of constructing a dynamo to embody the principles of my invention. Figs. 2 and 3 are diagrammatic figures illustrating the manner of winding. Fig. 4 is a vertical section showing the principles of my invention applied to a different form of dynamo. Fig. 5 is a central transverse section of another form of dynamo, the right hand thereof showing the windings in section and the left hand thereof illustrating, diagrammatically, the manner of winding. Fig. 6 is a vertical transverse section taken on the line 6 6, Fig. 7, showing my invention applied to a transformer. Fig. 7 is a top plan view, partly in section, of said transformer. Fig. 8 is a central vertical sectional view of another form of transformer. Fig. 9 illustrates in perspective the plates constituting the magnetic field of the latter transformer. Figs. 10 and 11 show, respectively, in perspective and central longitudinal section a modified form of transformer.

Referring to Fig. 1, it will be seen that I have provided a rotating field A and a stationary armature B, the latter being made up of laminated plates or stampings *b* and internal windings *b'*. If such a form of dynamo were to be built with usual windings, the wire would be wound around one or the other or all the iron walls constituting the shell or magnetic field of the armature B. Instead of this method of winding I inclose all the wires within the stampings and I wind the wire in a peculiar manner illustrated in Figs. 2 and 3, where it will be seen that beginning at the inner terminal b^2 the wire is carried in a winding parallel to the rotating field A in successive turns, as indicated by numbers in Fig. 3, so that the wire is built up in successive layers from the inside outward until half of the cavity (at one side the heavy line b^3, Fig. 1) within the stampings is entirely filled, and then the same method of winding is followed until the opposite half of the cavity is entirely filled, the outer layers of the two bodies of windings being joined in circuit, so that we have a U-shaped mass of windings with the opposite terminals thereof next to the rotating field A. This winding will be clearly understood by following the numbers in Fig. 3 and observing the graphic representation of said winding in Fig. 2, from which it appears that successive coils are made until opposite parallel layers are formed, (indicated, respectively, by the figures 1 3 5 7 and 2 4 6 8,) and then the same wire continues laying adjacent layers, (indicated, respectively, by the figures 9 11 13 15 on one side and 10 12 14 16 on the other side,) the same wire then being carried back in the next layer, as indicated on one side by 17 19 21 23 and on the other side by 18 20 22 24, and then the last peripheral coil made in the half of the cavity of the armature filled by the windings thus far described continues over to the other half of said cavity, being coiled in precisely the same manner as before, the turns, however, proceeding from the periphery inward in the reverse manner to that already explained. In other words, supposing the last peripheral turn on one side the line b^3 to be made by the wire 48, this wire is continued past the dividing-line b^3 to the side of the cavity, which we will suppose to be vacant, winding precisely as before the turns 48 47, 46 45, 44 43, 42 41, which form the outermost or peripheral layer adjacent the ends of the stampings *b*, the same wire being thence continued in its windings to form adjacent and within said outermost layer another layer, (represented by the figures on one side 40 38 36 34 and on the

other side 39 37 35 33,) and so on, winding in successive layers the same wire until said wire ends up with the last coil 2 1 of the last or innermost layer lying in line with the first or starting layer with which the winding was begun at the opposite end of the wire, the first coil 1 2 being at one terminal of the entire winding and the last coil 2 1 being at the other terminal thereof. The result is that as the field A rotates, thereby disturbing the induced magnetic conditions of the magnetic body B, which for the time being has become an induced magnet, the magnetic lines of the body B, when released from their inducing source, follow the usual law of induced magnets, and fall away from the region of the field A toward H, causing usual fluctuations in the winding of the armature, and the lines of force in the magnetic field provided by the enveloping body or jacket B fall on the wires of the windings and outwardly toward the ends thereof at H, thereby creating the greatest impedance at the adjacent portion of the windings and removing from the inner portions of the windings the hindrance of the lines of magnetic force, so that the rise of potential of the entire winding is free to take place at the terminals of the windings adjacent the field A, and consequently a high-potential region is maintained immediately adjacent the rotating field, and a low-potential region in the winding is maintained at the remote portions of the winding adjacent the parts marked H in Fig. 1. In Fig. 5 I have shown the same principle of winding applied to an armature made up of different-shaped stampings, the stampings shown in Fig. 5 having a central core portion b^4, around which the wire is wound. The principle of winding, however, is the same as before explained—that is to say, the current has to pass from the low-potential or outer portion of the armature along the entire length of the whole winding before it can reach the high-potential or inner portion of the armature adjacent the rotating field. This is different from previous windings in that the old way of winding would be to start, for instance, at the same end as in my winding; but instead of winding the wire outward in layers transversely to the portion b^4, as indicated, the wire would be wound directly on the portion b^4 in a spiral form throughout the length of said portion b^4, and then back again to the start in a second layer, and so on back and forth in layers extending parallel to the length of the armature instead of extending transversely thereto, and the result would be that the current would simply have to pass throughout the length of wire of one layer in order to pass from the low-potential region to the high-potential region of the armature, and then the current in traveling farther along the winding would pass back again along the next layer, traveling from the high-potential region to the low-potential region, and so on back and forth, according to the number of layers, until finally it would reach the outgoing terminal. I repeat, therefore, that the distinction of my winding thereover is that all the current as it is generated by the falling of the magnetic lines of force from the field A toward the end H is drawn off without impedance from the end of the winding away from which the lines of force are falling, and this takes place throughout the successive turns of the winding until every turn thereof back to the very end H discharges freely all its current in the one direction, all discharge in an opposite direction being prevented by the impedance of the lines of magnetic force at and falling toward the high magnetic potential ends H. Accordingly an armature constructed as shown in Fig. 5 would present constant high potential adjacent the rotating field, and the potential would be raised under the most favorable conditions, inasmuch as the lines of force of the surrounding magnetic field would be continually falling across the turns of wire back so as continually to keep releasing one and the same end of the winding from their impeding influence, while continuing to choke the opposite ends thereof adjacent H.

In Fig. 4 I have indicated the field at A′ and have provided a rotating armature B′, made up of stampings in usual manner, the difference over a usual dynamo being, however, that I have wound the armature as already described, b^5 indicating a ribbon winding, which begins adjacent the core of the armature and winds in successive layers thence outwardly in a radial direction, so that, for the reason already explained, there is a constant region of high potential adjacent the periphery of the armature and the inner terminals at the core are low potential. This is not only of advantage in that it gets all the benefit of the cutting lines of force in the magnetic field in the most natural manner as they fall across the turns successively from the inner to the outer portions of the windings, but also it requires only one terminal to be provided for the high-potential-current delivery from the apparatus, thereby permitting the return-conductor of the circuit to be correspondingly light and inexpensive for the extremely low voltage duty required of it.

In Figs. 6 and 7 I have shown a secondary C, wound in the same manner already described in detail and as shown in Fig. 1, the iron field *c* being cut away at *c′* to receive a primary preferably wound also on the same principle as the secondary. This produces what may be termed "a magnetic oscillator," in which all the lines of force of the magnetic field (whether closed or open) are permitted on an interruption of the current in the primary to fall across the secondary, so as to cut all the turns thereof successively from the center toward H and progressively throughout the length of the wire. In a transformer wound in the old way the lines of force would cut successive turns, to be sure, but would

not cut said turns progressively along the whole wire, inasmuch as the windings would be transverse to the direction that I employ. This will be more readily understood viewing Figs. 10 and 11, which show the magnetic field as made up of wires forming at the center a core c^2 and bent around the outside of the windings to form a jacket c^3. The old way of making a transformer in this form would have been to wind the primary along the core c^2 from one end to the other and then wind the secondary over the primary in successive layers parallel to the core back and forth. My winding, it will be seen, is entirely different from this, for I wind the primary c^4 at one end, as clearly indicated, and then wind the secondary c^5 in successive layers transversely to the core c^2 instead of parallel thereto, so that all the current passes out from the delivery or outgoing terminal c^7 without any impedance, because as the lines of force fall and cut the turns, beginning at c^7 and falling back toward the opposite terminal c^6, the wire is left free to discharge its current in one direction only, and this continues until all the wire is left free back to its terminal c^6. In Fig. 8 I have shown a form of transformer wound on the same plan, but having a central core c^{10} and opposite disk-like magnetic fields c^{11} c^{12}, connected therewith, the stampings in this case being made up of pieces c^{13} c^{14} (shown in detail in Fig. 9) and put together in an obvious manner.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an electrical apparatus, a body producing a magnetic field, a winding within the influence of said body, means to maintain high-potential and low-potential regions respectively in opposite parts of said magnetic field, and means to cause fluctuations of said field, said winding being wound to present conditions of electrical potential related inversely to the magnetic potential of the field, and having decreasing potential throughout its entire length from its high-potential region to its low-potential region, substantially as described.

2. In an electrical apparatus, an enveloping body providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, and means to cause fluctuations of said field, said winding having its terminals adjacent the region from which the magnetic lines fall on a fluctuation of said field, said winding being similarly wound from its said terminals to its intermediate portion, the latter being adjacent the region toward which said magnetic lines fall, and being wound to present decreasing potential throughout its entire length from its said respective terminals to its said intermediate portion, substantially as described.

3. In an electrical apparatus, a body providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, a primary winding restricted to the region of said field toward which the magnetic lines fall, said first-mentioned winding being wound in said field to present conditions of electrical potential related inversely to the magnetic potential of the field, said winding having decreasing potential throughout its entire length from its high-potential region to its low-potential region, substantially as described.

4. In an electrical apparatus, a magnetizable shell or jacket providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, a primary winding restricted to the region of said field toward which the magnetic lines fall, said first-mentioned winding having its terminals adjacent the region away from which the magnetic lines fall, being similarly wound from its said terminals to its intermediate portion, the latter being adjacent said primary winding, and said first-mentioned winding being wound to have its potential decreasing throughout its entire length from its said respective terminals to its said intermediate portion, substantially as described.

5. In an electrical apparatus, a thin, flat secondary winding wound in two similar bodies side by side proceeding from the intermediate portion of the winding constituting the secondary and each of said bodies winding in successive layers or coils progressively shorter throughout its length from the periphery to the central portion thereof, and a primary winding restricted to the peripheral portion of said secondary, part thereof being on one side and part on the opposite side of said secondary, substantially as described.

6. In an electrical apparatus, a thin, flat secondary winding wound in two similar bodies side by side proceeding from the intermediate portion of the secondary and each winding in successive layers or coils progressively shorter throughout its length from the periphery to the central portion thereof, and a primary winding restricted to the peripheral portion of said secondary, part thereof being on one side and part on the opposite side of said secondary, and a magnetic jacket or body inclosing said windings, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.

No. 619,761. Patented Feb. 21, 1899.

T. B. KINRAIDE.

DYNAMO ELECTRIC MACHINE.

(Application filed Sept. 29, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

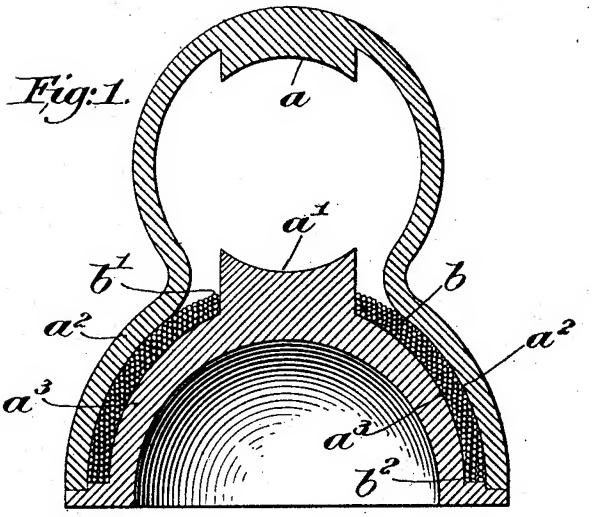
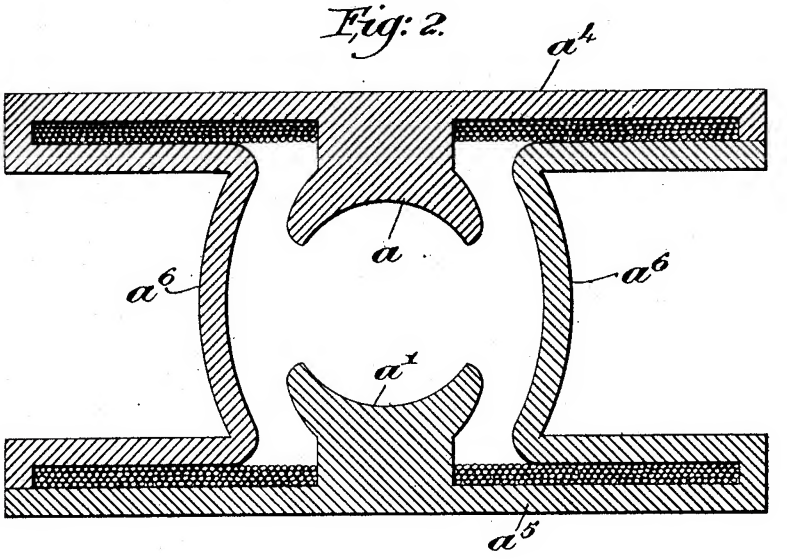


Fig. 2.



Witnesses,
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James M. Urquhart.

Inventor,
Thomas B. Kinraide,
by Crosby & Gregory.
Atty's.

No. 619,761. Patented Feb. 21, 1899.

T. B. KINRAIDE.

DYNAMO ELECTRIC MACHINE.

(Application filed Sept. 29, 1898.)

(No Model.) 2 Sheets—Sheet 2.

Fig: 3.

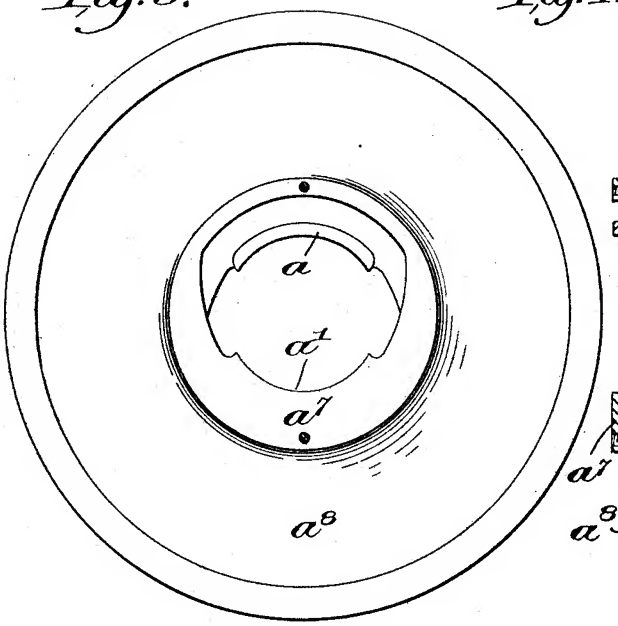


Fig: 4.

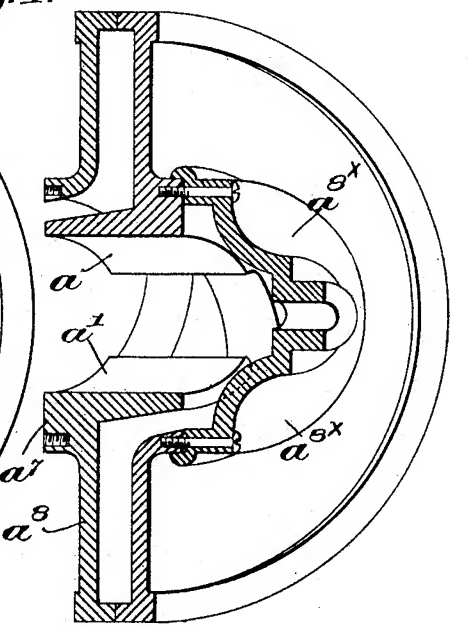


Fig: 5.

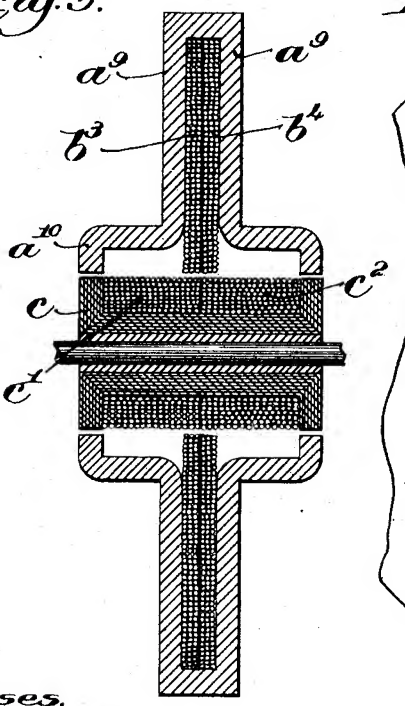
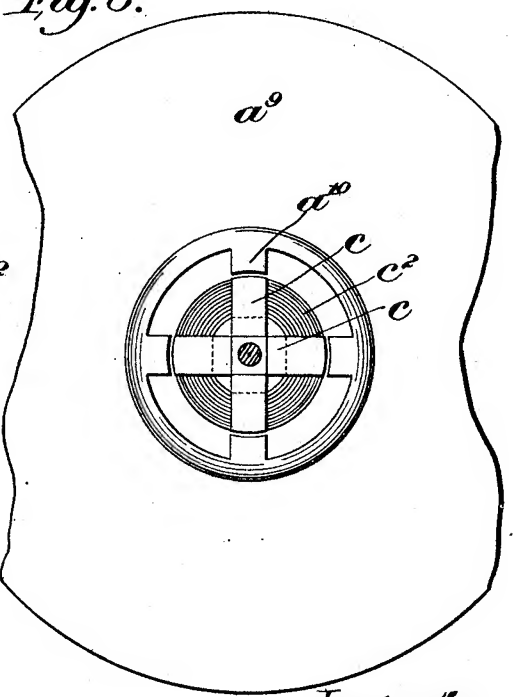


Fig: 6.



Witnesses,
Edward F. Allen.
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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 619,761, dated February 21, 1899.

Application filed September 29, 1898. Serial No. 692,159. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electrical Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is herein shown as applied to dynamos or motors, and it resides in the discovery or application of a new principle of winding, by which the lines of magnetic force are conveyed from a larger area to a smaller area for use, thereby producing polarization without any large extent of interior repulsion, such as is manifested in bar or cylindrical magnets or pole-pieces.

My invention might be termed a "focalizer" or "magnetic transformer" for the reason that it focalizes at the center all the lines of force from the successively longer turns toward the periphery. This gives quantitative effect and transforms the magnetic effect due to the lines of force from the longer turns at the periphery into magnetic potential at the center.

My invention will be more fully apprehended from the following description, taken in connection with the accompanying drawings, which are illustrative of different embodiments of my invention.

In the drawings, Figures 1 and 2 are central vertical sections of field-magnets constructed and wound to embody my invention. Fig. 3 is a view in side elevation, and Fig. 4 is a sectional perspective, of another form of field-magnet for a dynamo or motor embodying the same principles. Fig. 5 is a central vertical section, and Fig. 6 a side elevation, (partly broken,) of still another construction embodying the same invention, these figures showing the focalizer-field with extension-poles.

In Fig. 1 I have shown a field-magnet having two opposite pole-pieces $a\,a'$, which, it will be understood, coöperate with an armature, which, however, is not shown, inasmuch as it does not constitute part of my present invention, my invention relating to the form and arrangement of the field-winding. The field-winding is indicated at b, where it will be seen that instead of being wound around the pole-piece in the form of a cylinder, which would be the usual winding, it is wound with progressively longer coils or turns, the shortest turns being at b' and increasing in length from that point to the outer or peripheral turns at b^2. Preferably the winding is very thin, in order that it may have direct action upon an extended area of the magnetic-field material, and I have herein shown the respective poles as energized from the opposite parallel surfaces $a^2\,a^3$, thereby producing a motor or generator of the iron-clad type.

In Fig. 2 the pole-pieces $a\,a'$ are at the center of disks $a^4\,a^5$, connected at a^6 to constitute virtually one magnet.

Figs. 3 and 4 also show disk-shaped fields in which the pole-pieces $a\,a'$ project in opposite directions from the hubs a^7 of similar castings a^8, the latter preferably having extensions $a^{8\times}$ thereof to constitute journal-bearings for the armature-shaft. (Not shown.)

Figs. 5 and 6 show a four-pole alternator having a split winding made up of the two parts $b^3\,b^4$, which act on the disk-shaped field-magnets a^9 the same as in the other figures, the difference being, however, that the pole-pieces a^{10} are spread apart or extended, an armature being shown in position having stampings in the form of flat oblong strips of sheet metal c, bent at right angles opposite the pole-pieces and containing armature-windings $c'\,c^2$, which may or may not rotate with the armature, as may be preferred. This form of winding focalizes the magnetic lines to the best advantage and produces a quantitative effect at the pole-piece at the center.

One advantage of my new system or manner of winding is that much less winding is necessary for giving a practically-saturated pole-piece, and, moreover, the polarization of the lines of magnetic force takes place in the most natural manner without interior repulsion or pressure except at the place of use where required, and the lines of force are not wasted and dissipated. Their natural and normal outlet or direction of movement in or on the iron is toward the pole-piece at the center, where the polarization is desired. Also by having the winding spread out in thin layers, as shown especially in Figs. 1 and 2, there is a minimum conflict of lines of force in the windings themselves, there being merely enough thickness of winding over the surface

of the iron to generate just the number of lines of force which can be accommodated by the iron.

By this system of winding the field offers less resistance to the flow of the energizing-current, the strength of the field at the periphery being almost *nil*, while at the center the concentration gives great strength, and on account of this low resistance I am enabled to obtain a much higher degree of saturation in the coil of the armature, and in consequence much greater efficiency from the machine.

By spreading the pole-pieces, as in Fig. 5, I am enabled to employ an armature or secondary winding of very many turns and small diameter, which produces high voltage.

I have chosen for illustration in explaining my invention castings adapted to dynamos or motors; but it will be understood that my invention is not restricted in this respect, but may be used for transformers of various descriptions and, indeed, for a wide range of electrical work, and I intend herein to claim the same broadly.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an electrical apparatus, an electromagnet for producing a magnetic field, and means for polarizing or converging the lines of magnetic force of said magnet from a large area thereof to a smaller area or pole, said means including a winding spread out coextensively with said large area and immediately adjacent to the surface of said magnet, substantially as and for the purpose set forth.

2. In an electrical apparatus, an electromagnet having its center of polarization substantially coincident with the mechanical center of the magnet, said magnet extending therefrom in a relatively thin body of constantly-increasing circumferential area from said center, and a relatively thin winding for said magnet, said winding having its turns constantly longer as they recede from said center of polarization, substantially as described.

3. In an electrical apparatus, coöperating magnets having central pole-pieces or places of polarization, said magnets each extending laterally in divergent directions from their respective regions of polarization, and windings for said magnets, said windings proceeding from said central pole-pieces outwardly along the surfaces of said radiating parts of the magnets in turns longer as they recede from the said pole-pieces, and said magnets inclosing their said windings between them, substantially as described.

4. In an electrical apparatus, coöperating magnets having central pole-pieces or places of polarization, said magnets each extending laterally in divergent directions from their respective regions of polarization, and windings for said magnets, said windings proceeding from said central pole-pieces outwardly along the surfaces of said radiating parts of the magnets in turns longer as they recede from the said pole-pieces, and said magnets inclosing their said windings between them, the said pole-pieces being spread apart, and an armature to coöperate with said pole-pieces, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 623,316. Patented Apr. 18, 1899.

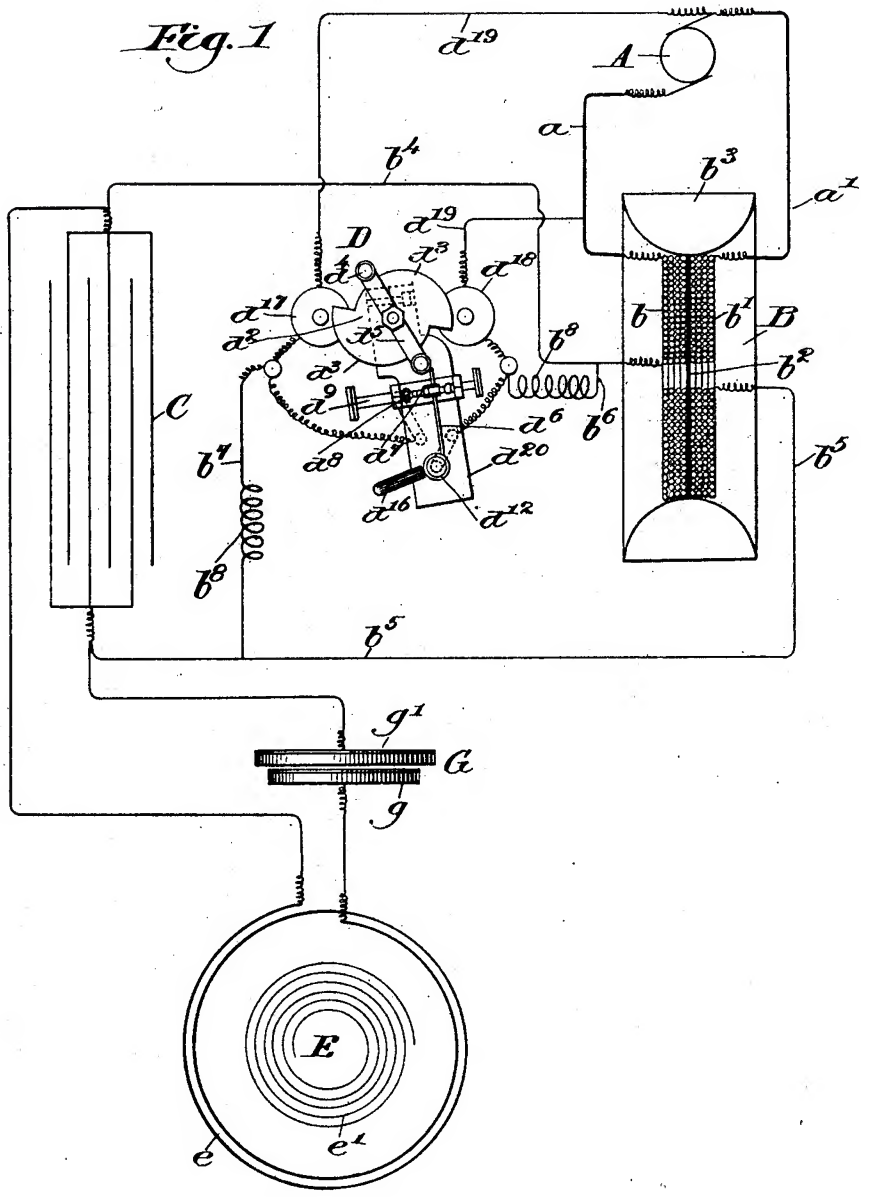
T. B. KINRAIDE.

INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1



Witnesses:

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by Crosby & Gregory

Attys.

No. 623,316. Patented Apr. 18, 1899.

T. B. KINRAIDE.

INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

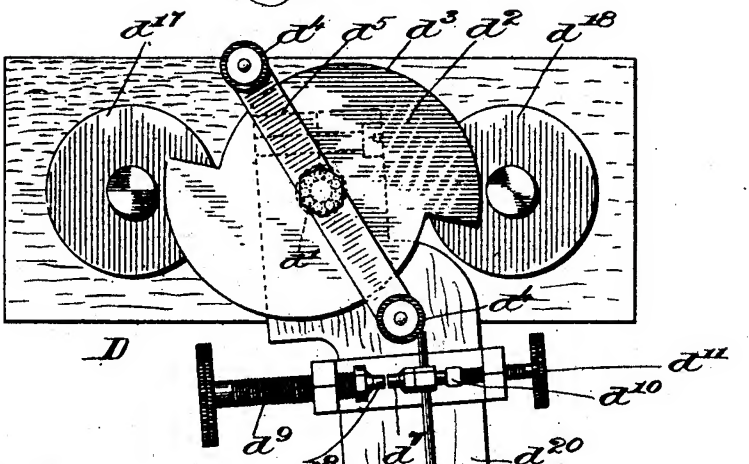


Fig. 4.

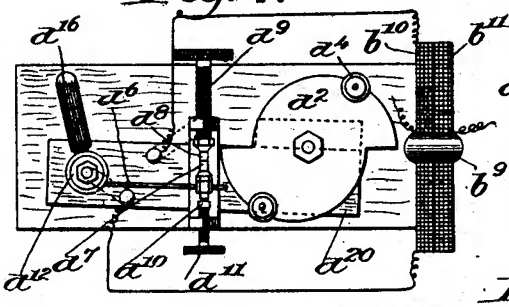
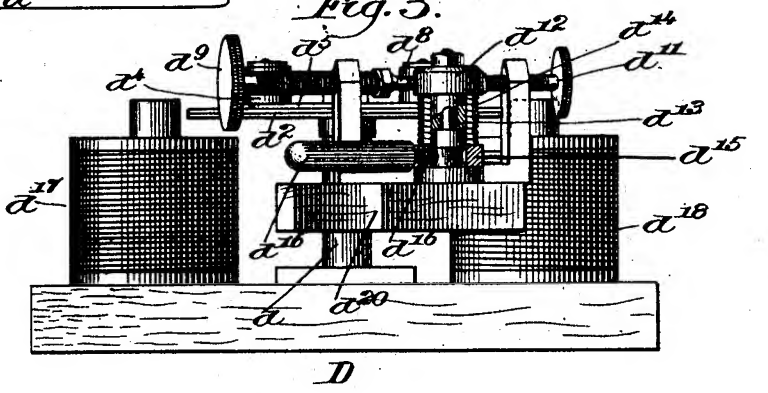


Fig. 3.



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Fred. S. Grumbach.

Inventor:

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attys.

No. 623,316. Patented Apr. 18, 1899.

T. B. KINRAIDE.

INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 5.

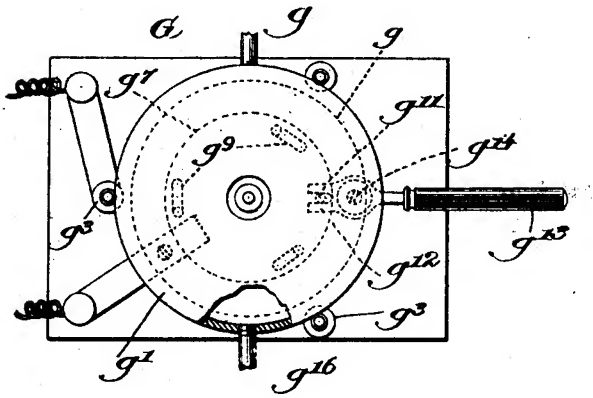
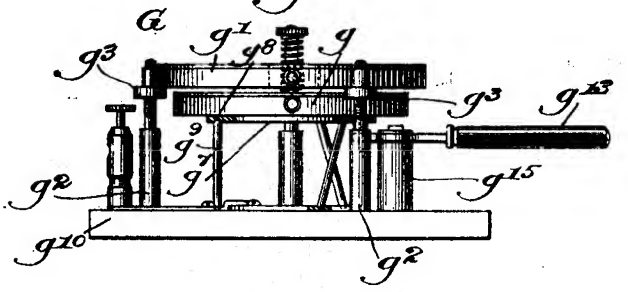


Fig. 6.



Witnesses:

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Inventor:

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by Lemby & Gregory

Atty.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 623,316, dated April 18, 1899.

Application filed May 5, 1898. Serial No. 679,799. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an improved induction apparatus whereby discharges are made possible of greater efficiency, as will more fully appear in the course of the following description.

I will describe the details of my invention with reference to the accompanying drawings, which illustrate a preferred form of the apparatus.

In the drawings, Figure 1 is a view, partly diagrammatic and partly in section and plan, illustrating the arrangement of the system according to my invention. Fig. 2 is a top plan view of the break. Fig. 3 is a front elevation thereof, parts being broken away to show the detailed construction. Fig. 4 is a view similar to Fig. 2, showing a modified form thereof. Fig. 5 is a top plan view of my improved spark-gap. Fig. 6 shows the spark-gap in elevation.

Heretofore there has always been a considerable amount of waste energy in systems for developing high potential, and also there has been an ever-present danger of breaking down and destroying the apparatus by its own output, and accordingly it has been my present aim to provide a system in which all the increase of potential which may be developed shall be delivered for use for the translating devices and in which the apparatus is self-containing and practically indestructible.

Let A designate a dynamo, battery, or any other suitable source of electrical energy. From the dynamo the current passes by conductors a a' to an inductance device B, each conductor a a' having its own coil b b', said coils being preferably insulated from each other, as indicated at b^2, and surrounded by a laminated core b^3. Each coil b is wound transversely back and forth until the opposite terminals b^4 b^5 reach the center and are thence carried to the opposite ends of a condenser C, a break D being interposed and connected to the main conductors b^4 b^5 at b^6 b^7 and the discharge from the condenser being received by a translating device (herein shown as a special induction-coil E) by means of an automatic spark-gap G.

Each one of the details of apparatus above enumerated as constituting my system is of special construction and peculiar effect in the system, whereby it becomes possible to discharge currents of considerable strength with great velocity through the primary of the coil E, the discharge across the spark-gap being of very great amperage and exceedingly short and sharp oscillations.

Referring now to the inductance device B, I will explain that the object of this device is to raise the potential of the current and cause all this increase of potential to pass to the condenser, preventing any of it from discharging through the dynamo.

By my device the total potential is delivered only from the forward end of the wire or the one toward the condenser, and also there is only one end of the coil which has high potential. This is because the lines of magnetic force occasioned by the flow of the electric current, which during said flow are radiated from the core or field b^8, fall from the center across all the turns of wire into the periphery as the circuit is interrupted, and hence maintain a region of constant magnetic intensity at the periphery, effectually checking all rise of potential at that end, but leaving the opposite or outgoing end free from the presence of the lines of magnetic force as soon as the break occurs, and therefore without impedance. As soon as the current is broken the lines of force fall back toward the iron core and leave the central portion of the coil free from the restraining influence of these lines of force, said lines cutting across the successive turns of wire, the coil being left free to permit the induced current of increased potential to flow toward the center of the coils or toward that point which has no magnetic field whatever to choke back the current, thereby permitting the latter to rush out unconfined and unrestrained toward its natural outlet; but as the lines of the magnetic field are constantly maintained with maximum impedance at the periphery of the coil and remain surrounding the peripheral turns until the very last moment of the fall due to the break in the circuit their presence

there prohibits any possibility of manifestation of the rise of the potential in the current at that end of the coil, so that all the increase of potential in the whole coil is obliged to find an outlet from the center, and the ease of outflow from this outlet increases as the lines of force fall away from the center, thereby removing their restraining and impeding influence therefrom. This will be clear by bearing in mind the action which takes place in what is commonly called a "choke-coil"—*i. e.*, a winding about an iron core, said winding being in a spiral from one end of the iron to the other. In such a coil it is obvious that when a current passes the lines of force rise equally along the extent of the entire coil and that when the current is broken the lines of force fall directly in, perpendicular to the core, thereby cutting each turn of the spiral equally and at the same time, thereby producing high pressure at both ends of the choke-coil, the potential being necessarily the same at both ends of the wire, because both ends are affected by the same conditions of falling lines of force.

In my coil the lines of force do not fall equally on all the turns; but there is a minimum intensity at the center and a maximum intensity at the periphery, the latter being the point of entrance of the current, so that the current due to self-induction is always free to be drawn off, as it were, into the condenser at one end as fast as it is developed and is prevented from departing at the opposite end, or, stated in other words, while the current from the dynamo is always free to flow into the coil for having its potential raised the said potential must all seek its outlet at the opposite end of the coil, so that all the current of the coil flows therefrom into the condenser, whereas in a choke-coil the induced current may be said to ooze out at both ends, so that the benefit is not received of all that is developed.

By my coil all the lines of force are collected for cutting from the center across the entire coil, whereas in the usual choke-coil the lines of force that fall at the center cut only the central turns, so that in my coil I develop all the potential that is possible to be developed.

I regard it as a new principle to withdraw the lines of magnetic force away from that portion of the coil from which the current is being drawn and maintain a magnetic field at that portion of the coil which receives the current.

Other features of construction to be noted in the coil shown in Fig. 1 are that the high-potential end of the coil is that portion of least resistance, because the central turns are of course shorter than the peripheral turns. The resistance in the coil diminishes as the potential increases; also, it will be observed that I have given the magnetic core substantially the form of a semicircle in cross-section, my reason for this form being that thereby the lines of magnetic force are given their best radiation or are distributed to the best effect on the coil, it being understood that these lines leave the iron perpendicular to its surface and are gradually bent around toward the coil.

Referring now to the break D, (best shown in Figs. 2 and 3,) I journal in a central post or bearing d the spindle d' of an iron plate or armature d^2, having two or more eccentric edges d^3, as clearly shown in Fig. 2, or other provision of regions of increasing magnetic attraction. Mounted on or otherwise connected to rotate therewith are one or more small antifriction-rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5, clamped adjustably on the plate d^2. These rolls or circuit-interrupters are preferably of indurated fiber. Mounted to extend into the path of the rolls d^4 is an arm (shown as a wire d^6) carrying a hammer d^7 to contact with an anvil d^8 on a post d^9 and limited in its movement by a fiber stop d^{10} on the end of an adjusting-screw d^{11}. The wire d^6 is carried by a hub d^{12}, loose on a pin d^{13} and held under tension by a spring-coil d^{14}, Fig. 3, fastened at one end to said hub and at its other end to a nut d^{15}, carrying an adjusting or set screw d^{16}, so that by loosening the set-screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied. Opposite the surfaces d^3 I place solenoids or electromagnets d^{17} d^{18}, operated by taps d^{19} from the main circuit entering the solenoids at their inner terminals, so that as the magnets d^{17} d^{18} are energized they attract the plate d^2, and by the increasing pull exerted thereon on account of the eccentric surfaces d^3 they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^6, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling-magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break. Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post d, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other. The same effect may be obtained by shifting the roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted; but this adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus and of the system I provide the swinging carrier d^{20}. A movement of the carrier from right to left in the diagram causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved farther toward the left the

pull on the armature exerted by the magnets is diminished more and more and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks and at the same time lengthening the time which the circuit of the inductance-coil is closed. This is of great importance, because thereby it results that the degree of magnetic saturation of the core or field b^3 may be increased up to its highest limit.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 2, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end.

The mains b^4 b^5, Fig. 1, are connected, as stated, to the break by the conductors b^6 b^7, and in order that the condenser may not discharge back through the break I interpose in these conductors a resistance, herein shown as consisting of a few small turns b^8. The discharge from the condenser will seek the path of least resistance, and therefore I interpose just sufficient resistance at b^8 to prevent said discharge acting through the break, but not enough to render the condenser inoperative. One object of this special break is to make it possible to get all the efficiency out of the inductance apparatus B that there is. This would be impossibe with any usual break, for the reason that if a usual break were used, so as to give an equivalent period in which the circuit was closed, the brush would remain upon the surface of the break, tending through the heat or friction engendered to arc upon it, so that the condenser could not receive the full charge from the inductance-coil, but a portion would be lost upon the break-surface. My break, however, gives an absolutely instantaneous break, this break, moreover, being of extremely short duration, so that in practice I am enabled to leave the circuit closed during thirty-five thirty-sixths of the period of rotation of the break-armature, thereby leaving the inductance-coil B all of this period in which to raise its potential. It will be understood that as the point of highest saturation of the core is approached the discharge into the condenser is much greater in volume than if the magnetic flux were not complete.

In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break. Thus I am enabled to avoid entirely the considerable loss of energy heretofore consumed by the break, and I am enabled by the use of this break, in connection with the special inductance-coil B, to charge the condenser with an amperage which has not been possible in any system heretofore. Also by reason of the spark-gap G, which I will now describe, I am enabled to maintain the condenser action at the maximum charge and without any danger of breaking it down.

I provide electrodes in the form of opposite parallel disks g g', the air-gap between whose plane surfaces constitutes the spark-gap, the extended area of these electrodes preventing the tendency of the condenser to discharge until it has reached its maximum charge, and also causing the discharge to be exceedingly sudden when it does take place and the disks not being liable to become unduly heated. The spark-gap G constitutes virtually a self-recuperative or indestructible condenser, as it were, the parallel and preferably plane metallic surfaces g g' being the discharge-surfaces which discharge through or across the intervening air-dielectric. The air-gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the disks are the farther apart they will spark. At each discharge of the condenser a small portion of these plates is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two disks are completely oxidized. Referring to Figs. 5 and 6 for the details of this spark-gap, it will be seen that I provide a plurality of posts g^2, threaded at their upper ends and carrying shouldered nuts g^3, on the shoulders of which is placed the top disk g', being held accurately on said shoulders by a spring g^4 under a tension-nut g^5, said nut and spring being mounted on the reduced end of a central post g^6, over which the plates g g' are placed. The opposite plate g rests on a support or table g^7, provided on its under side with a plurality of recesses or sockets g^8, herein shown as three in number, which receive props or struts g^9, projecting upwardly from the base g^{10} of the instrument. These props g^9 are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g'. The support g^7 has depending from its lower side a stud g^{11}, which is engaged by the bifurcated end g^{12} of a lever g^{13}, pivoted at g^{14} to a post g^{15} on the base. By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other, so as to incline the struts g^9 more or less, and thereby increase or decrease the distance between the plates g g', the nuts g^3 being depended upon for the coarser adjustments of the plates.

I have shown the plates g g' as hollow and provided with water-circulation pipes g^{16} in order that they may be absolutely prevented from all heating under extraordinary conditions.

The induction-coil E comprises a primary e of large cross-sectional area, capable of receiving a considerable amperage, the secondary e' being wound on the principle explained in connection with the coils b b', so that its inner terminal alone has the high-potential

discharge, the other terminal having comparatively no discharge. I do not herein claim this induction-coil, inasmuch as it forms the subject of another application and is therein claimed; nor will I herein further describe the details thereof, merely showing this particular coil for the reason that this is the only coil known to me which can be used for obtaining the best results from my system; nor do I herein claim the special break device, nor the special spark-gap, inasmuch as these form the subjects-matter of other applications, Serial Nos. 691,757 and 691,758, filed September 24, 1898, and are therein claimed, and it will accordingly be understood that while these particular instruments are preferably employed in my system I do not intend to restrict the latter thereto, nor otherwise than as expressed in the following claims. The conditions that are obtained in this system make it possible to discharge currents of enormous strength with great velocity through the primary, the velocity obtained making it possible to raise the potential in the secondary enormously, and the said potential being confined to one terminal only a resulting discharge is obtained representing the total of the potential that otherwise would be manifest at both terminals of an ordinary coil.

The spark-gap G is adjusted to the point of discharge of the condenser which it is desired the latter should maintain, and accordingly said condenser is automatically discharged as often as it rises to said point of maximum charge, and it can never be overcharged, for the reason that the spark-gap remains unvarying.

The use of the plates g g' makes possible the sudden discharge of the condenser after it has reached the certain predetermined point mentioned, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark-gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations, incapable of being obtained between a ball or point discharge-gap and productive of very great results in the secondary.

The plates g g' of the gap G are adjusted to the potential at which it is desired the condenser C shall discharge, and then the break D is regulated to give the volume or amperage of current which it is desired shall charge the condenser, the latter being automatically discharged as frequently as its charge reaches the predetermined limit to which the spark-gap has been adjusted. For example, supposing that the break D is adjusted so as to require the inductance device B to operate at its saturated point, as before explained. Then the number of discharges of the condenser across the spark-gap during each fluctuation in the coil B will be many more times than if the break D were operating more rapidly, and hence the rapidity of the discharge from the induction-coil E is increased in its efficiency, giving more volume of discharge.

It must be understood that the potential that is developed in the induction-coil E is not as great when the plates g g' are brought near together as it is when they are far apart, because in the latter case the condenser charge becomes greater necessarily before it is discharged. By increasing the length of the spark-gap, the speed of the break remaining the same, I get an increase of potential in the oscillator or induction-coil E, and also I may obtain the same effect without varying the length of spark-gap by decreasing the speed of the break.

The maximum potential obtainable from the induction-coil is when the break is adjusted to rotate at a speed sufficient to permit the saturation of the core b^9 and the spark-gap at G is lengthened so that the condenser is allowed to charge to its full capacity.

The sudden opening of the break-gap wide enough so that no discharge may take place thereat, but all the charge seeks a much better channel of discharge in the condenser, taking place as it does in an exceedingly small interval of the period of rotation of the break, gives the inductance-coil B volume of discharge such that it may charge the condenser a considerable number of times before another break takes place; or, to put this in another way, my apparatus enables me to produce a charge from the device B of such enormous volume that the spark-gap G will be called upon to automatically discharge the condenser a number of times during the interval of one falling of the lines of force in the inductance device B.

I regard myself as the first to provide an induction system capable of automatically regulating itself so as to maintain a given discharge, and I also believe myself to be the first to provide an apparatus capable of maintaining said condenser-discharge at a given amperage.

The frequency by my system is practically unlimited, inasmuch as a plurality of inductance devices B may be connected independently to the break D and condenser C, merely being arranged to operate out of step with each other, and there will be no danger to the condenser, for the reason that the spark-gap G will take care of all the charge which may be delivered to the condenser.

My system enables me to use a small condenser and yet with enormous efficiency therefrom.

While I have herein described preferred embodiments of my invention, I do not restrict myself thereto. For example, the electromagnets d^{17} d^{18} need not be used; but instead thereof the inductance device B may be oppositely wound, as indicated in Fig. 4, so that the core b^9 will be properly located for

running the armature d^2 of the break. In this case I make the ends of the core b^9 hemispherical, thereby obtaining the same advantage before explained in connection with the similarly-shaped surfaces of the core b^3, and the coils b^{10} b^{11} will be wound back and forth transversely in the same manner as the coils b b', the difference being that in this case the inner terminal becomes the low-potential end of the coils for connection to the dynamo and the outer terminals are the high-potential ends of the coils for connection to the condenser, this form of apparatus, however, not being so efficient as the form previously described, for the reason that the outer or longer turns present an increased resistance to the higher potential, whereas the best effects can be obtained, as before explained, by presenting a decreasing resistance to an increasing potential.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a system of the kind described, an electric circuit, means including a condenser to impress thereon a current of high frequency, combined with means for automatically discharging the condenser at any predetermined degree of charge, and means for varying the amperage charge of the condenser, substantially as described.

2. In a system of the kind described, a source of electrical energy, and a condenser, combined with a device for raising the potential of the current, means for discharging said raised potential solely in one direction from said device, and means for controlling the potential of said device, substantially as described.

3. In a system of the kind described, a source of electrical energy, a break, condenser, and a translating device to receive the discharge from the condenser, combined with means for preventing the discharge of the condenser back through the break, substantially as described.

4. In a system of the kind described, the combination with a source of electrical energy, a break, and condenser, of an inductance device between said source of energy and the break, said device having a magnetic core, and coils in the influence of said core and wound to present high potential at one end and low potential at the other end, said coils having their low-potential terminals connected to the source of energy, and their high-potential terminals connected to the condenser, and interrupted by the break, substantially as described.

5. In a system of the kind described, the combination with a source of electrical energy, a break, and condenser, of an inductance device between said source of energy and the break, said device having a core producing a magnetic field, and coils in the influence of said field and wound to present high potential at one end and low potential at the other end, said coils having their low-potential terminals connected to the source of energy, and their high-potential terminals connected to the condenser, and interrupted by the break, and means to vary the degree of magnetic saturation of said field in the operation of the system, substantially as described.

6. In a system of the kind described, a source of electrical energy, a break, and a condenser, combined with means independent of the break for automatically regulating the frequency of discharge from said condenser, substantially as described.

7. In a system of the kind described, a source of electrical energy, an inductance device for raising the potential of the current therefrom, said device delivering said potential in one direction only and away from the source of energy, a break provided with means for maintaining long intervals of closed circuit, and sudden short intervals of break, a condenser, and an automatic discharge device for said condenser, substantially as described.

8. In a system of the kind described, a source of electrical energy, an inductance device for raising the potential of the current therefrom, said device delivering said potential in one direction only and away from the source of energy, a break provided with means for maintaining long intervals of closed circuit, and sudden short intervals of break, a condenser, means preventing back discharge from the condenser and sparking at the break, and an automatic discharge device for said condenser, substantially as described.

9. The combination in an electrical circuit, of an inductance-coil having a core producing a magnetic field and wound to present a high-potential region at one end and low-potential region at the other end, the terminal thereof connected with the source of current-supply being at said low-potential region, and the opposite terminal being at said high-potential region, said coil having the potential thereof decreasing in a constant ratio from the one to the other terminal, and mechanism for interrupting the said circuit, said mechanism comprising means for maintaining the circuit closed in periods sufficient to fully charge said magnetic field, substantially as described.

10. An inductance-coil comprising a core, and a winding of current-conductor centrally of said core, said winding being in two coils, each having one terminal adjacent said core and the other terminal removed from said core, with all the windings of the coil located between said two terminals, and said coil having its potential varying per turn progressively in a constant ratio throughout its length from one terminal to the other terminal, substantially as described.

11. In an inductance-coil, a peripheral core or magnetic body, and a winding of current-conductor within the field of said magnetic body, said conductor being wound to present

its successive layers of windings successively shorter from the periphery to the center of the coil throughout the entire length of the conductor, substantially as described.

12. In an inductance device, a magnetic core, and a coil adjacent thereto, said core presenting curved surfaces adjacent the coil curving therefrom in a direction away from the coil, whereby the lines of magnetic force leaving the core perpendicular to said surfaces are widely distributed about the coil, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
FREDERICK L. EMERY.

No. 623,317. Patented Apr. 18, 1899.

T. B. KINRAIDE.

ELECTRICAL BREAK.

(Application filed Sept. 24, 1898.)

(No Model.)

Fig: 1.

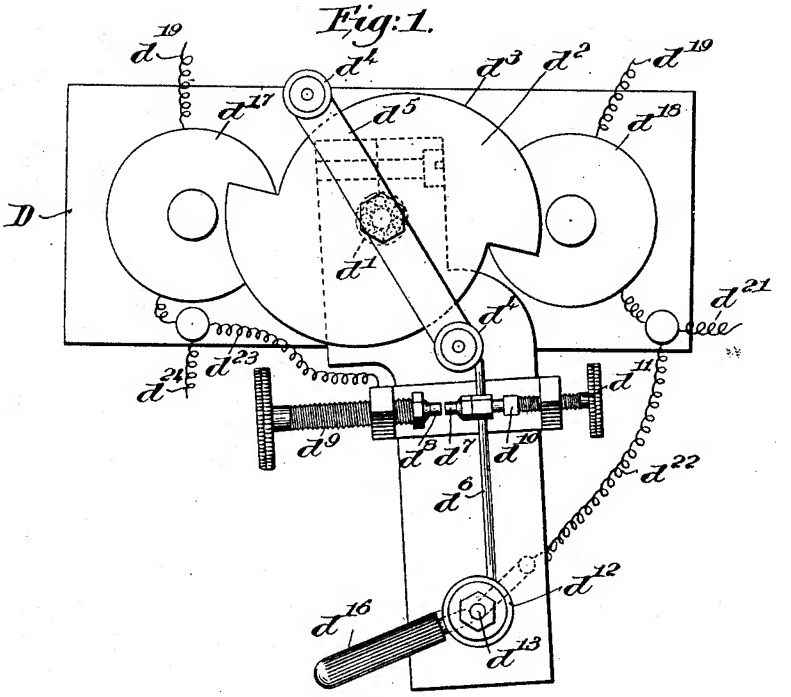
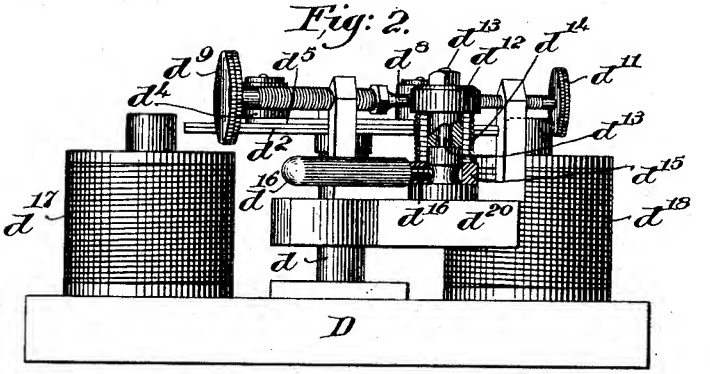


Fig: 2.



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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL BREAK.

SPECIFICATION forming part of Letters Patent No. 623,317, dated April 18, 1899.

Original application filed May 5, 1898, Serial No. 679,799. Divided and this application filed September 24, 1898. Serial No. 691,757. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electric Breaks, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present application is a division of my application, Serial No. 679,799, filed May 5, 1898.

Electric breaks as heretofore provided have been subject to considerable sparking, which is not only destructive of the apparatus, but is very objectionable in its effects on the current and system being operated, this being especially true of rotary breaks which operate by means of a brush in frictional engagement with a rotating surface. Accordingly I have invented a break in which there is no chance for arcing, as there is no surface to arc over, and also a leading object of my break is to provide a means for making an exceedingly quick break with a relatively long period of closed circuit, my break rendering it possible to regulate the period of closed circuit accurately. Many considerable advantages resulting from this construction will occur to those skilled in the art.

The details of construction and principles of operation of my improved break will be more fully pointed out in the following description, reference being had to the accompanying drawings, in which I have illustrated a preferred embodiment of my invention, and the latter will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a top plan view of one form of my break. Fig. 2 shows the same in elevation.

On a suitable base D, I journal, in a central post or bearing d, a spindle d' of an iron plate or armature d^2, having two or more regions of varying mass of magnetic material, herein shown in the form of eccentric edges d^3, as clearly shown in Fig. 1.

My object is to provide regions of increasing magnetic attraction to coöperate with one or more suitable electromagnets or solenoid devices so located as to successively attract these regions of varying mass of magnetic material for rotating the armature, as will now be explained.

Mounted on or otherwise connected to rotate with the armature d^2 are one or more small antifriction-rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5, clamped adjustably on the plate d^2. These rolls or circuit-interrupters are preferably of indurated fiber.

Mounted to extend into the path of the rolls d^4 is an arm, (shown as a wire d^6,) carrying a hammer d^7 to contact with an anvil d^8 on a post d^9 and limited in its movement by a fiber stop d^{10} on the end of an adjusting-screw d^{11}. The wire d^6 is carried by a hub d^{12}, loose on a pin d^{13} and held under tension by a spring-coil d^{14}, Fig. 2, fastened at one end to said hub and at its other end to a nut d^{15}, carrying an adjusting or set screw d^{16}, so that by loosening the set-screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied.

Preferably adjacent the periphery of the armature d^2 I place attracting means, herein shown in the form of solenoids or electromagnets d^{17} d^{18}, connected with the main or other source of current by wires d^{19}, which enter the solenoids at their inner terminals, so that as the magnets d^{17} d^{18} are energized they attract the armature or plate d^2, and by the increasing pull exerted thereon on account of the eccentric surfaces d^3 they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^6, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling-magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break.

Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post d, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other. The same effect may be obtained by shifting the

roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted. This adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus I provide the swinging carrier d^{20}.

A movement of the carrier from right to left causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved farther toward the left the pull on the armature exerted by the magnets is diminished more and more, and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks and at the same time lengthening the time which the circuit being interrupted is closed.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 1, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end. The arm d^6 is connected to the main or branch therefrom at d^{21} by means of any suitable conductor d^{22}, and the anvil d^8 has a connection d^{23} to the delivery end d^{24} of the circuit, as will readily be understood.

In operation the magnets being energized attract the eccentric surfaces or other varying masses of magnetic material, so as to cause the armature to rotate over to the left, Fig. 1, the circuit being completed at d^7 d^8 until the very moment when the interrupter d^4 strikes the free end of the arm d^6, whereupon the circuit is instantaneously broken, and as this time occurs slightly before the highest points or places of greatest attraction of the armature come opposite the solenoids the latter are rendered inactive merely during the moment when the momentum of the armature is carrying the latter by the solenoids, so as to bring the region of least magnetic mass again opposite the solenoids in position for the latter, upon becoming active by the making again of the circuit, to renew their pull upon the armature, and thereby continue its rapid revolution. This action is rapidly repeated at every make and break of the instrument.

I prefer to provide opposite solenoids in order to render the device perfectly balanced and smooth-running, although it will be understood that variations in this and in all other details of my invention may be made.

By the use of my invention the time-period of closed circuit may be made as considerable as desired. With any usual break this would be impossible, for the reason that in order to give an equivalent period of closed circuit the brush would of necessity remain upon the surface of the break so long as to heat frictionally the surfaces, so as to produce a constant arc, ultimately destroying the break as well as the efficiency of the circuit. In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An electric break comprising a rotating member, an electromagnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, substantially as described.

2. An electric break comprising a rotating member, an electromagnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

3. An electric break comprising a rotating member, an electromagnet, a spring, a break device, means to vary the resistance of said break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

4. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter driven by said rotating member for interrupting the break device, substantially as described.

5. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, substantially as described.

6. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, substantially as described.

7. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, and means

for adjusting said roll on said rotating member, substantially as described.

8. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a bar fixed on said rotating member and provided with rolls pivoted thereon at its opposite ends in line with and to interrupt said break device, substantially as described.

9. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, said break device being mounted on a carrier movable concentrically to said rotating member, substantially as described.

10. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a revolving interrupter driven by said rotating member, said break device including a yielding arm projecting obliquely into the path of said interrupter, substantially as described.

11. An electric break comprising an arm carrying a hammer, an anvil opposite said hammer, said arm being yieldingly supported and provided with means for regulating the tension or resistance thereof, an interrupter for engaging the free end of said arm, and automatic means operated by the current being broken for driving said interrupter, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 623,318. Patented Apr. 18, 1899.

T. B. KINRAIDE.

ELECTRICAL SPARK GAP.

(Application filed Sept. 24, 1898.)

(No Model.)

Fig: 1.

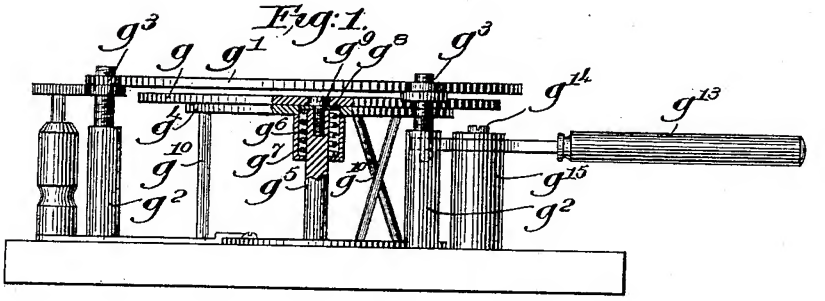


Fig: 3.

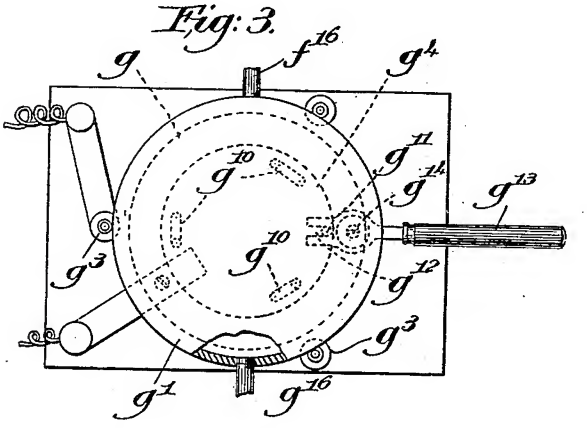
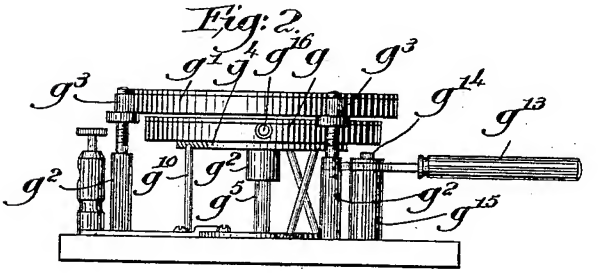


Fig: 2.



Witnesses,
Edward H. Allen.
James M. Urquhart.

Inventor,
Thomas B. Kinraide
by Crosby & Gregory
Atty's.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL SPARK-GAP.

SPECIFICATION forming part of Letters Patent No. 623,318, dated April 18, 1899.

Application filed September 24, 1898. Serial No. 691,758. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electric Spark-Gaps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The more recent developments in electrical matters, and particularly in the line of experimental research in connection with static electricity, have developed conditions requiring the discharge of such enormous potentials and amperage as to render the apparatus heretofore provided for such purposes inefficient and largely useless, for the reason that these enormous discharges which the electrician frequently desires to experiment or deal with very quickly render inoperative or destroy such usual apparatus.

Accordingly it is the object of my present invention to provide a practically indestructible discharge apparatus to meet the more exacting requirements of the present day; and to that end I provide a spark-gap which is virtually self-recuperative and comprises opposite parallel discharge-surfaces of considerable area, which, besides their practically indestructible character, possess numerous very important advantages, all as will be more fully pointed out in the course of the following detailed description of the apparatus, reference being had to the accompanying drawings, illustrative of preferred embodiments thereof.

In the drawings, Figure 1 represents in side elevation a simple form of my improved spark-gap. Fig. 2 is a similar view showing a modification. Fig. 3 is a top plan view of the form of apparatus shown in Fig. 2.

While the spark-gap which constitutes my invention and which I will now describe is primarily intended for use in discharging condensers, as shown in my application, Serial No. 679,799, filed May 5, 1898, it will be understood that it is not limited thereto, but may be employed in various other relations.

I provide electrodes preferably in the form of opposite parallel disks g g', the air-gap between whose plane surfaces constitutes the spark-gap, the extended area of these electrodes preventing the tendency of the condenser, for example, to discharge until it has reached its maximum charge and also causing the discharge to be exceedingly sudden when it does take place and the disks not being liable to become unduly heated.

The spark-gap constitutes virtually a self-recuperative or indestructible condenser, as it were, the parallel and preferably plane metallic surfaces g g' being the discharge-surfaces, which discharge through or across the intervening air dielectric. The air-gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the disks are the greater condenser capacity will they have, and hence the farther apart they will spark.

At each discharge of the condenser a small portion of the plates g g' is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two disks are completely oxidized. Suitable means is provided for accurately adjusting these plates relatively to each other and regulating their distance apart, or, in other words, for controlling the resistance of the intervening gaseous dielectric, and, referring to the drawings, where I have shown a preferred means for accomplishing my object, it will be seen that I provide a plurality of posts g^2, threaded at their upper ends and carrying shouldered nuts g^3, on the shoulders of which is placed the top disk g'. The opposite plate g rests on a support or table g^4 and is mounted loosely on a post g^5, being normally held downwardly by a spring g^6, contained in a hanger or housing g^7, depending from the table g^4, said spring bearing at one end against the flanged lower end of the hanger g^7 and at its other end bearing against a washer g^8, retained by a screw g^9, whose head enters a hole or recess in the plate g for centering the latter.

The plate g is provided on its under side with a plurality of recesses or sockets, herein shown as three in number, which receive props or struts g^{10}, projecting upwardly from the base of the instrument. These props g^{10} are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g'. The support g^4 has depending from its lower side a stud g^{11}, which is engaged by the bifurcated end g^{12} of a lever g^{13}, pivoted at g^{14} to a post g^{15} on the base.

By this provision the most delicate adjustment is possible simply by swinging the lever g^{15} one way or the other, so as to incline the struts g^{10} more or less, and thereby increase or decrease the distance between the plates $g\,g'$, the nuts g^3 being depended upon for the coarser adjustments of the plates.

In Figs. 2 and 3 I have shown the plates g g' as hollow and provided with water-circulation pipes g^{16} in order that they may be absolutely prevented from all heating under extraordinary conditions. Under usual conditions, however, this provision is entirely unnecessary, it being sufficient simply to provide the plates, as shown in Fig. 1.

When the adjacent surfaces of the plates have become entirely oxidized, the plates may be turned over and their opposite sides used, and when both sides have become oxidized they may be readily removed and scoured off without destroying any of their adjustments.

My apparatus makes possible the sudden discharge of a condenser after the latter has reached a certain predetermined point, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark-gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations incapable of being obtained between a ball or point discharge gap.

The adjustment of the plates relatively to each other regulates the amperage-discharge of the instrument being discharged.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A spark-gap of the kind described for use in a condenser-circuit, said spark-gap presenting opposite parallel discharge-surfaces of relatively large areas and means for regulating the discharge distance between said parallel surfaces, whereby a condenser charge may be automatically governed, substantially as described.

2. The herein-described spark-gap comprising opposite electrodes presenting parallel discharge-surfaces, one of said electrodes being supported on three or more struts of equal length, and means for rotating said strut-supported electrode about its center, whereby its adjustment may be varied to and from the opposite electrode, substantially as described.

3. A spark-gap, comprising two permanent large superficial areas parallel to each other, constituting opposite discharge-surfaces, and an interposed gaseous dielectric, said discharge-surfaces having condenser capacity for breaking down the intervening dielectric, and the latter automatically restoring or renewing itself, substantially as described.

4. A spark-gap comprising opposite hollow plates or disks having parallel discharge-surfaces, means for regulating the discharge distance between said surfaces, and circulation-pipes entering the same, whereby a circulation of water may be maintained for keeping the plates or disks cool, substantially as described.

5. A spark-gap comprising three or more posts, shoulders adjustable thereon, a plate or disk supported on said shoulders, a second plate below the same, a support therefor, three or more upright struts loosely engaging said support, and means to rotate said support about its center, whereby said struts are simultaneously and similarly moved for varying the distance apart of said plates, substantially as described.

6. A spark-gap comprising a central post, a plurality of supporting-posts, two plates, one carried by said supporting-posts and the other adjacent said central post, three or more similar struts supporting said lower plate, a spring maintaining said struts in proper supporting relation, and means to rotate the lower plate on said central post, substantially as described.

7. A spark-gap comprising a plurality of supporting-posts, two plates, the lower plate being pivotally mounted, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting-posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

8. A spark-gap comprising a central post, a plurality of supporting-posts, two plates, the lower plate being pivotally mounted concentrically to said central post, a hanger depending adjacent said post, a spring between said post and hanger and engaging the hanger at its lower end and held by the post at its upper end, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting-posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

ALEXANDER C. PROUDFIT.

No. 676,583. Patented June 18, 1901.

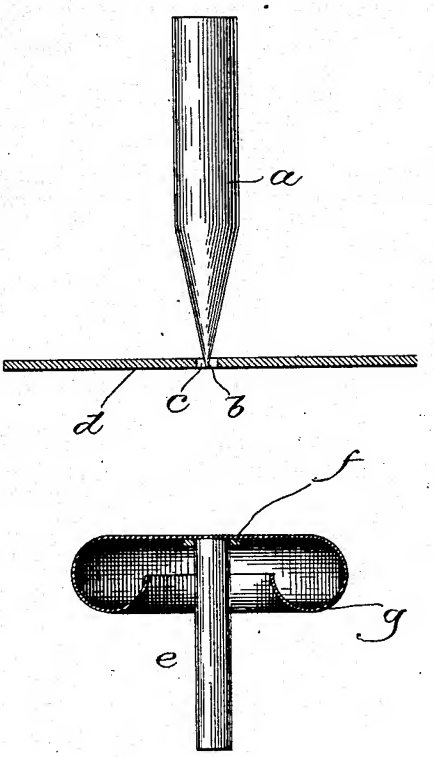
T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed Aug. 13, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1



Witnesses.
Thomas J. Drummond.
Adolf L. Kaiser.

Inventor.
Thomas B. Kinraide,
by Lemby & Gregory
Atty's.

No. 676,583. Patented June 18, 1901.

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed Aug. 13, 1900.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

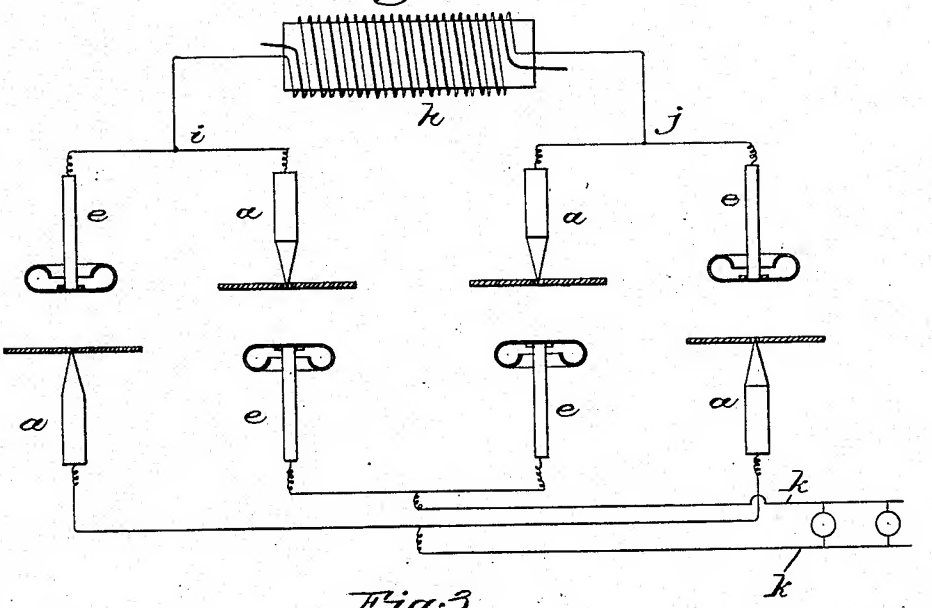
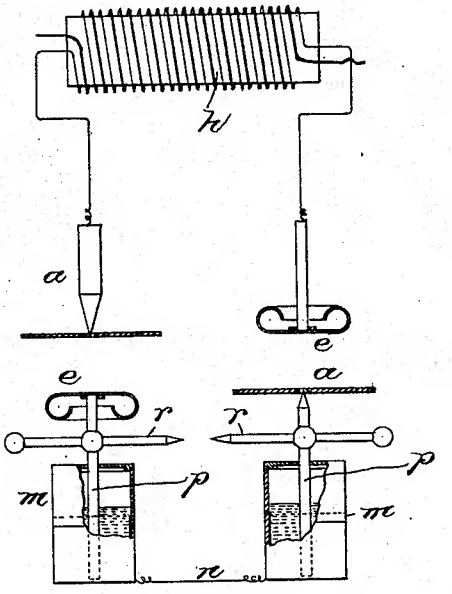


Fig. 3.



Witnesses.
Thomas J. Drummond.
Adolf L. Klauer.

Inventor.
Thomas B. Kinraide,
By Bradley Gregory
Attys.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 676,583, dated June 18, 1901.

Application filed August 13, 1900. Serial No. 26,709. (No model.)

To all whom it may concern:

Be it known that I, THOMAS BURTON KINRAIDE, a citizen of the United States, and a resident of Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Electrical Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is of wide application to various kinds of electrical apparatus and embodies certain important discoveries which I have made whereby I am enabled to positively maintain an electrical discharge in one direction only and under proper conditions to maintain said discharge continuously, producing, for instance, without the intervention of a commutator a continuous current directly from an alternating or intermittent current. Without necessarily stating that such is the fact, it may be supposed that there is simply electrical energy and that the presence of said energy is what we call a "positive" condition, and the absence of said energy is what we call a "negative" condition, and this, taken with my discovery that electric energy in its positive condition discharges reluctantly from a plane (without edges or angular or pointed surfaces) and discharges with perfect freedom from a point, enables me to control the direction of discharge of the current, and hence the accumulation of potential. The requisite conditions are provided by means of what I term an "extensionless point," which provides, as nearly as it can be done mechanically, the ideal discharge-electrode or positive condition for the outward flow of the electrical energy, and by means of what I term a "limitless plane," which provides in the same manner the receptive electrode or negative condition, in which there may be said to be an absence of energy (or a lower potential than that of the point from which the discharge comes) corresponding to a vacuous condition or absence of electrical pressure. By this means the electrical energy tends to discharge continuously in one direction only—viz., from the extensionless point to the limitless plane.

In the drawings, in which I have illustrated, largely diagrammatically, one form of my invention, Figure 1 represents, partly diagrammatically and largely in vertical cross-section, two electrodes arranged to provide the conditions above explained. Fig. 2 illustrates the application thereof for transforming an intermittent current into a constant current. Fig. 3 illustrates the application of my invention to Leyden jars for converting an intermittent discharge into a continuous discharge.

The general structural features of my invention may be very briefly stated.

Referring to Fig. 1, it will be seen that the electrode *a* is pointed or pencil-shaped and that the extreme discharge-point *b* is in or projected slightly through a small aperture *c* in a rubber or other flat disk *d*, which extends at right angles thereto, the purpose of this disk being to cut off the attracting area which would otherwise be present in the converging walls or surfaces of the electrode *a*. By this means I provide an "extensionless point," speaking electrically. By this term I mean a point in which the attractive area of the electrode relatively to the opposite electrode is limited to the point itself, or, in other words, in which the rubber disk *d* shields all the surface of the rod or electrode behind the very point thereof. The rubber disk constitutes means for cutting off the receptive area about the discharge-point. Opposite the electrode point *b* is the receptive electrode *e*, which maintains a negative condition relatively to the electrode *a* and which I have termed the "limitless plane," speaking again electrically, this electrode having a large receptive area and being provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface or plane without angles or points, and this plane is secured by providing a flat surface *f* of considerable relative extent and curving its edges back and inwardly, as indicated at *g*, whereby, viewed electrically, the surface is limitless, inasmuch as it has no termination within the influence of the discharge-point *b*.

In operation, the positive energy discharges invariably from the point *b* to the plane *f*, and there is no discharge from the latter back to the point, one reason therefor being that the attraction of the limitless plane is compelling, there being practically no attraction

in the opposite direction due to the shielded point.

Applying the invention to practical uses, it will be seen that its field is important and large.

In Fig. 2 I have indicated a typical source of intermittent or alternating energy in the form of an induction-coil *h*, (operated by an alternating current,) whose terminals *i j* are provided with electrodes *a e* of the kind already described, and opposite these electrodes, which are arranged in pairs, are complementary electrodes *e a*, connected to a working circuit *k*, which it is desired shall have a continuous current.

Remembering that, as already explained, the extensionless-point and limitless-plane electrodes compel the discharge to take place in one direction, it will be seen that the intermittent or alternating discharge from the coil *h* is automatically transferred into a continuous current by the lower sets of electrodes as arranged in Fig. 2.

Again referring for further illustration to Fig. 3, it will be seen that I have arranged two Leyden jars *m*, having their outer coatings electrically connected by a wire *n* and their inner coatings connected by posts *p*, in which are mounted usual discharge-rods *r*, said posts, however, being provided on their upper extremities with the electrodes *a e*, opposite electrodes *e a* at the terminals of a coil *h*, (operated by an interrupted current.) By this means it is possible to maintain constant discharge at an approximately fixed potential similar to the discharge from a static machine, as the intermittent discharge from the induction-coil, which is the source of supply for the Leyden jars, is enabled to keep the Leyden jars at a practically saturated point, so that the latter can maintain a constant discharge between their rods *r*. This application of my invention is of great practical importance for the electrical spinning of fine fibers, such as silk, the rapid evaporation of liquids, and the accomplishment of effects that can be produced by the continuous running of a static machine. The static machine necessarily leaks, is not subject to control, and is of necessity uncertain, whereas by my invention all these objections are removed and the static discharge is rendered continuous and uniform.

My invention is what might be called an "electrical check-valve," as it permits the unlimited discharge of the current in one direction, but checks it from discharging in the opposite direction.

In measuring the effectiveness of my invention I have found that upon arranging the source of supply in such a manner that a positive discharge could be compelled to pass from the electrode *e* to the electrode *b* the electrodes could only be one-quarter the distance apart that they could be when the current was passing in the opposite direction, and even then the current had to be forced or compelled to discharge, because, if possible, it would seek some other outlet in preference to the one desired for the sake of experiment.

It will be understood that the practical embodiment of my invention may be varied within a wide range of equivalent embodiments, and accordingly I do not limit myself otherwise than as is hereinafter expressed in the claims, nor do I limit myself in respect to the applications of my invention, as, for instance, it is useful as a spark-gap capable of definite control; also, for a lightning-arrester and a multitude of other uses.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described means for producing a continuous or unidirectional discharge, consisting of electrodes one of which has a discharge-point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge, as set forth.

2. An electrode terminating in a comparatively fine point, and a flat shield extending approximately at right angles to said electrode and having a small aperture in which said point is located.

3. An electrode terminating in a plane, conducting-surface, having its edges curved or rolled rearwardly and inwardly.

4. In an electrical apparatus, a source of intermittent electrical energy having at its opposite terminals electrodes one of which has a discharge-point provided with means for cutting off the receptive area about said discharge-point and the other of which has a large receptive area provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface without angles or points, and other electrodes coöperating with said terminal electrodes, there being a discharge-point electrode arranged to coöperate with a receptive-area electrode and vice versa.

5. In an electrical apparatus, a source of intermittent electrical energy of high potential, means for compelling a unidirectional discharge from one end thereof, means opposite said end for receiving said discharge, said means being incapable, under ordinary conditions, of transmitting a back discharge, and means coöperating therewith for storing and maintaining said charge at an approximately fixed potential and maintaining a constant discharge therefrom.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.

No. 689,199. Patented Dec. 17, 1901.

T. B. KINRAIDE.

ELECTRODE.

(Application filed May 2, 1901.)

(No Model.)

Fig. 1.

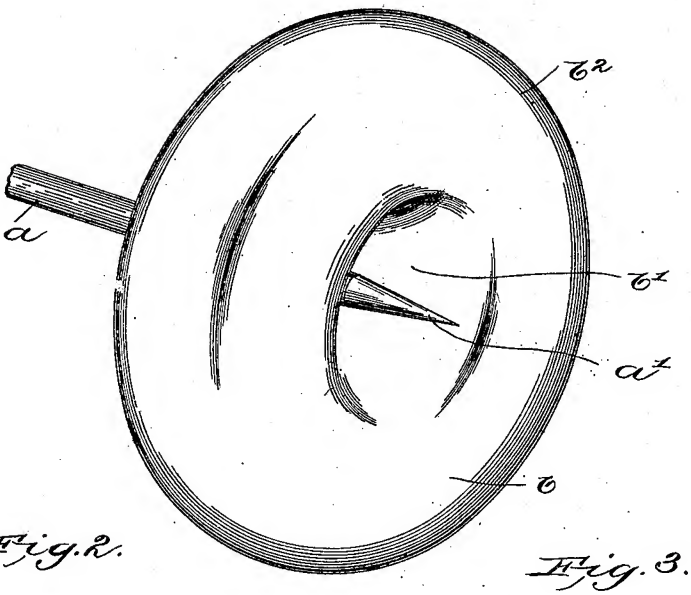


Fig. 2.

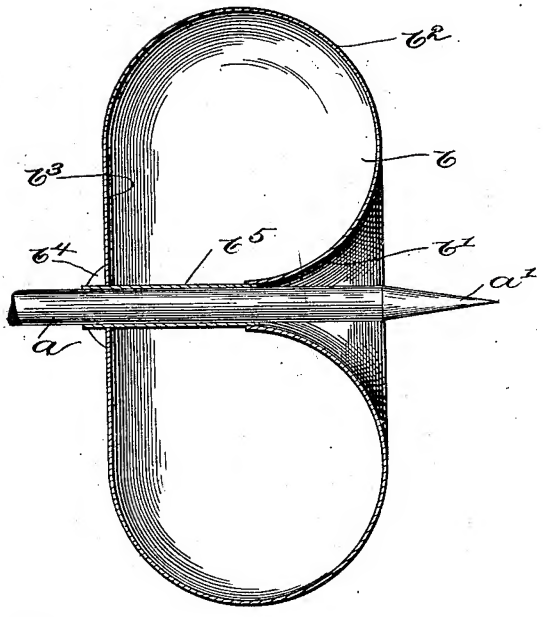
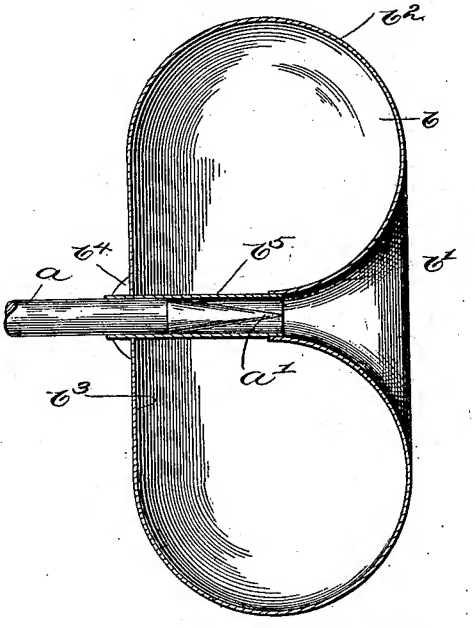


Fig. 3.



Witnesses.
W. C. Linsley
C. B. Kaiser

Inventor.
Thomas B. Kinraide
by Duncan & Regory.
Attys.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 689,199, dated December 17, 1901.

Application filed May 2, 1901. Serial No. 58,511. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electrodes, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is an electrode having for its object the regulation of the discharge effects or capabilities of the electrode.

As is well known, in certain situations of electrical discharge—as, for instance, in connection with the discharge-electrode of a Leyden jar—there is a tendency to continuous leakage, which prevents the full charging of the jar, and, again, it is sometimes desirable to check the brush-discharge—as, for instance, in an induction apparatus—especially when the two discharge-terminals are separated some distance, and also it is frequently convenient to be able to reverse the direction of discharge between two electrodes. Accordingly I have devised the hereinafter-described electrode for accomplishing, among other things, the above results, and in effecting my purpose I have availed myself of the principles set forth in my application, Serial No. 26,709, filed August 13, 1900, by combining the extensionless-point feature with the limitless-plane feature, as defined in my said application.

In the preferred construction of my present electrode I mount the point-discharge or discharge-rod adjustably in the center of the limitless plane, shaping the latter to correspond, so that it will maintain itself, electrically speaking, as a receiving plane or surface without edges or angular or pointed surfaces.

Further description of my invention and the operation thereof will be set forth in the following portion of the specification by reference to the accompanying drawings.

In the drawings, Figure 1 is a perspective view of my electrode. Fig. 2 is a vertical cross-section thereof. Fig. 3 is a view similar to Fig. 2, showing the electrode in a different adjustment.

It will be understood that my electrode is applicable to any conductor, the latter being herein indicated as a rod a, having at its forward end a point-discharge a', formed integrally therewith. Mounted on the rod a just back of the point a' is the limitless-plane portion b of the electrode, herein shown as having a central inwardly-sloping curved surface b', forming a bell-shaped mouth or opening, in the center of which is the point a'. The limitless-plane portion of the electrode extends from this central bell-shaped portion outwardly in such manner as to have no angular or pointed surfaces, being herein shown as curved around at b^2, substantially as shown in my before-mentioned application, the rear portion of the shell or surface extending at b^3 back to the rod a and being joined at b^4 to a tubular or sliding portion b^5 thereof. The purpose of this construction is to permit the point and surface to be moved relatively to each other so that the point may occupy an extended position, as shown in Fig. 2, or an intermediate position, as shown in Fig. 1, or a retracted position, as shown in Fig. 3, the portion b being in my present construction simply shoved backward or forward on the rod a. When the point projects forward, as indicated in Fig. 2, the electrode operates freely as a point-discharge; but when the parts are in the position shown in Fig. 3 the point is rendered inactive by reason of its inability to discharge past the extended surface b, which is charged with the same electricity as the point, this extended area of charged surface of like electricity repelling the discharge tendency of the point. Also by moving the two parts in one direction or the other a minimum or maximum charge or tendency to discharge may be maintained. For instance, as shown in Fig. 2, there is the greatest freedom of discharge, and this decreases as the shielding or screening influence of the limitless plane portion b is moved forward toward the point.

If, for example, my electrode is employed as a discharge-terminal of a Leyden jar and it is desired to check the brush discharge that takes place in the Leyden jar, causing the same slowly to "leak," as it is termed, all that is necessary is to move the surface b into screening position relatively to the point, thereby insuring a maximum charge of the jar. When thus charged, my electrode makes

it possible to discharge the charge across a much greater air-gap by means of the screened point than is possible with simply usual discharge-terminals.

I have not undertaken to set forth in this specification all the uses to which my invention may be put, as it will be understood that it is applicable to a practically endless range of uses in connection with electrical apparatus.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An electrode having a discharge-point, and means for electrically screening said point for limiting the tendency thereof to discharge.

2. An electrode having a discharge-point, and adjustable means for electrically screening said point for varying the tendency thereof to discharge.

3. An electrode having a comparatively fine point combined with a plane conducting-surface having its edges curved or rolled rearwardly and inwardly, and means for moving said surface relatively to said point.

4. An electrode having a plane conducting-surface shaped without edges or angular or pointed surfaces, combined with a point-discharge mounted within the area of said surface and projecting therefrom.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

WILHELMINA C. HENSER.

No. 724,186. PATENTED MAR. 31, 1903.

H. JACKSON.

ELECTRICAL APPARATUS FOR THERAPEUTICAL WORK.

APPLICATION FILED JAN. 22, 1903.

NO MODEL.

Fig. 1.

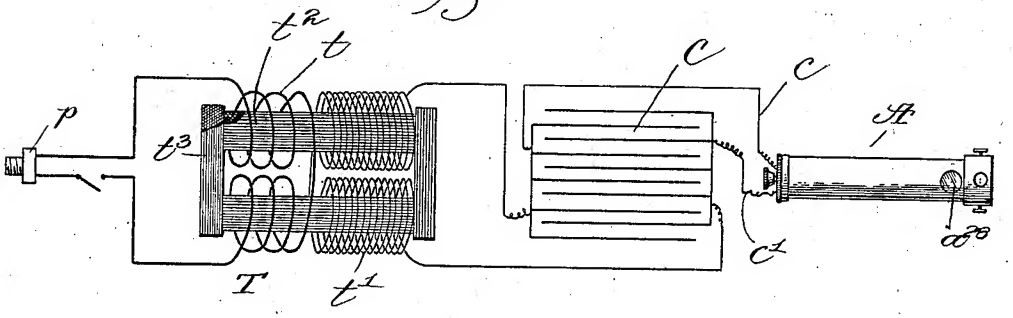


Fig. 2.

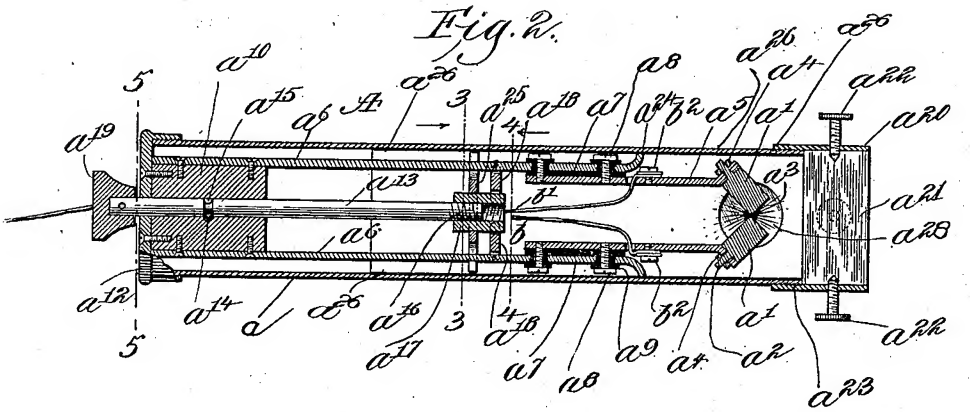


Fig. 3.

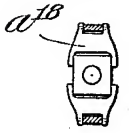


Fig. 4.

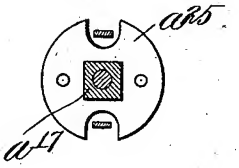
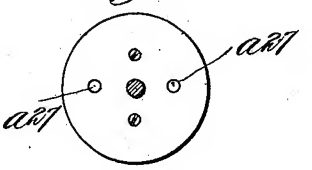


Fig. 5.



Witnesses.
W. C. Linsford.
Thomas F. Drummond.

Inventor.
Howard Jackson,
by Crosby Gregory.
Attys.

UNITED STATES PATENT OFFICE.

HOWARD JACKSON, OF NEWTON, MASSACHUSETTS.

ELECTRICAL APPARATUS FOR THERAPEUTICAL WORK.

SPECIFICATION forming part of Letters Patent No. 724,186, dated March 31, 1903.

Application filed January 22, 1903. Serial No. 140,161. (No model.)

To all whom it may concern:

Be it known that I, HOWARD JACKSON, a citizen of the United States, residing at Newton, county of Middlesex, and State of Massachusetts, have invented an Improvement in Electrical Apparatus for Therapeutical Work, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an apparatus for producing ultraviolet rays for Finsen treatments, and by the latter term I intend to include the various forms of treatment suggested by medical men in the general line of Dr. Finsen's experiments, whereby various bacteriological growths are destroyed or their growth retarded by exposure to strong ultraviolet rays.

The object of my experiments and investigation has been to render this great discovery practically available to the medical profession generally by producing an apparatus capable of generating a superior light at minimum cost, thereby bringing the apparatus itself within the reach of all and making it possible to reduce the time required for successful treatment to such a short period as to adapt it to the frailest subject.

The constructional details and further advantages of my invention will be pointed out in the course of the following description, reference being had to the accompanying drawings, in which I have shown a preferred embodiment of my invention.

In the drawings, Figure 1 is a diagrammatic view of the apparatus complete. Fig. 2 is a central longitudinal section of the light-tube. Figs. 3 and 4 are cross-sectional views of the latter, taken, respectively, on lines 3 3 4 4, Fig. 2. Fig. 5 is an end view of said tube, taken on line 5, Fig. 2.

Referring more particularly to the light-producing tube A, which constitutes one of the important features of my invention, it will be seen that it comprises a tube a, which may be of any desired material suitable for the purpose and capable of withstanding the usage to which it is put, and mounted suitably in a tube are the electrodes and operating mechanism therefor.

The electrodes which I prefer to use are composed of iron, as indicated at a', said electrodes being short and provided at their supported ends with threaded studs a^2 and made square at their free ends a^3, being held in position by any suitable means, as by nuts a^4, which serve to clamp them against supports a^5, carried on an adjusting-frame, herein shown as consisting of opposite rods a^6, insulated from said supports at a^7 and connected thereto by screws a^8, mounted in insulating-bushings a^9. The frame a^6 has a block a^{10} at one end, preferably secured to a cap a^{12}, provided for closing the tube at one end, and in said block is mounted a rod a^{13} free to rotate, but held against longitudinal movement by a pin a^{14}, occupying a groove a^{15} in said rod. At its inner end the rod a^{13} is in threaded engagement at a^{16} with a nut a^{17}, connected by toggle-links a^{18} to the frame, so that upon rotating the rod a^{13} by its thumb-nut a^{19}, which projects through the cap a^{12}, the electrodes a' may be adjusted as required. Adjacent the end carrying the electrodes I provide a screen-holder a^{20}, adapted to receive a block of ice, rock-salt, or other suitable substance a^{21}, which may be held therein in any suitable way, as by means of set-screws a^{22}, and is removably mounted by threads or otherwise on the tube, as indicated at a^{23}. The frame a^6 preferably has its free end turned out, as indicated at a^{24}, to center the same and also preferably carries a spider or centering means a^{25} intermediate its length, and the tube a has an insulating-lining a^{26}, of asbestos or other material, adapted to withstand the heat and insulate the outside case or tube. Feed-wires b b' are secured at b^2 to the supports a^5 and pass out through the cap a^{12}, as indicated at a^{27}. Suitable sight-windows a^{28} are provided for watching the electrodes.

One main purpose of my invention is to obtain a light of maximum efficiency, whereby the time required for an exposure is reduced to a minimum, so as to avoid the necessity of a tedious and dangerous exposure or treatment.

I have found that by my apparatus the exposure can be reduced to an exceedingly-short period, five minutes being sufficient in some instances.

The iron electrodes are very rich in actinic

rays, and by having their ends square I get an exceedingly sharp effect, and a further very important feature of my invention resides in providing, in connection with a condenser C, a step-up transformer T, which may receive its current from any usual alternating commercial circuit of one hundred to one hundred and ten volts, to which it may be connected by a usual electric-light plug *p*.

For general use the transformer may be wound with eight layers of three hundred and four turns of No. 16 magnet-wire for the coarse winding *t* and twenty layers of sixteen hundred turns of No. 24 wire for the fine winding *t'* on cores t^2, six by one and five-eighths inches, composed of fine iron wire connected at their ends by laminated iron yokes t^3 one and one-fourth by one and three-fourths by four and one-half inches, and as thus constructed the condenser of micanite sheets and tin-foil has a capacity of about one-fourth of a microfarad connected by heavy flexible conducting-wires *c c'* to the lamp A for carrying the rapidly-oscillating current.

This apparatus is not only relatively inexpensive, but can be used with any commercial alternating current, as stated. The apparatus is very readily portable and does not require a skilled operator, is rapid in its work—a treatment requiring only two to five minutes is capable of treating a large area satisfactorily—and is inexpensive to operate. It will run steadily without heating and does not require adjustment, except at long intervals, and the light is exceedingly rich in ultraviolet rays.

In the foregoing description I have stated the size and proportions which I have found the best for a convenient portable apparatus; but it will be understood that by increasing the condenser a larger arc may be produced, the transformer being modified within limits by using larger wire for carrying increased current; and it will be understood that I have set forth herein the said preferred proportions as an example to enable those skilled in the art to apprehend more clearly my invention.

For practical use it is necessary that the ultraviolet rays shall preponderate, and one object of my invention is to produce these rays in abundance without at the same time generating to an appreciable extent the other rays of the spectrum, or, in other words, I do not produce an intense light and then eliminate therefrom the superfluous and undesirable rays, (which is an expensive and cumbersome process;) but I have devised an apparatus which arrives at the desired result directly by producing the ultraviolet rays in great abundance by having a condenser operated by an alternating-current step-up transformer in time to deliver a high-tension high-frequency current directly to the arc-lamp. It is well known that a current of this character will produce an arc rich in ultraviolet rays. By my apparatus these rays are produced in an inexpensive, simple, and easily-operated mechanism capable of long continuous use.

I have aimed to produce an apparatus safely operable by a person not specially skilled and at a low cost, portable, and capable of operation with current commonly available.

My apparatus requires practically no attention, excepting turning the switch and occasionally adjusting the electrodes.

While I prefer to use iron electrodes, I do not wish to limit myself thereto, except where specified in the claims. These electrodes are mounted at an angle of about ninety degrees, as shown, and are held rigidly at one end, being capable of being turned to bring new portions of the sharp corners into action at the arc, these electrodes being inexpensive, long-lived, readily mounted, highly actinic, not liable to injury, interchangeable, and economical.

When it is desired to renew the screen a^{21}, the holder can be quickly removed from the tube and another put in place, or the screen material may be released by loosening the thumb-screws and a fresh supply substituted.

When it is desired to remove the electrodes or get at them, this may be done quickly simply by unscrewing the cap a^{12} and slipping the whole connected apparatus out of the tube.

Without undertaking to set forth all the modifications in form and arrangement of my apparatus and the various further advantages thereof, what I claim as new, and desire to secure by Letters Patent, is—

1. An apparatus of the kind described, comprising in series a source of alternating current, a step-up transformer and a condenser for producing a high-tension, high-frequency current, and an arc-lamp operated thereby for producing ultraviolet rays, substantially as described.

2. An apparatus of the kind described, comprising in series a source of alternating current, a step-up transformer and a condenser for producing a high-tension, high-frequency current, and an arc-lamp operated thereby for producing ultraviolet rays, said lamp being provided with iron electrodes, substantially as described.

3. An apparatus of the kind described, comprising in series a step-up transformer, a condenser, and an arc-lamp for producing ultraviolet rays, said lamp having square-ended iron electrodes arranged at an angle to each other for producing an arc between them, substantially as described.

4. In an apparatus of the kind described, a lamp comprising a case, a frame therein, electrode-supports carried thereby, and iron electrodes fixed rigidly on said supports, and means for adjusting said supports toward and from each other, substantially as described.

5. In an apparatus of the kind described, a lamp comprising a case, a frame therein, sup-

ports carried thereby, square-ended electrodes mounted in said supports, said electrodes being capable of being rotated in said supports, but immovable longitudinally therein, substantially as described.

6. In an apparatus of the kind described, a lamp, comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising toggle-links and an operating member therefor connected with said links and extending outside of the case, substantially as described.

7. In an apparatus of the kind described, a lamp comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising toggle-links, a nut connecting the same, and a threaded rod in engagement with said nut, said rod extending beyond the case, substantially as described.

8. In an apparatus of the kind described, a lamp comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising a threaded rod for operating said links, said rod extending beyond the case, substantially as described.

9. In an apparatus of the kind described, a lamp comprising a case, a removable cap therefor, a frame rigidly connected to said cap, supports carried by said frame, electrodes mounted on said supports, whereby the frame and all parts connected therewith can be bodily removed with said cap, substantially as described.

10. In an apparatus of the kind described, a lamp, comprising a case having at one end a cap and at the other end a removable screen-holder provided with means for detachably holding a screen of ice, a frame, supports and electrodes, all carried by said cap, and means for maintaining the same out of contact with the case, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HOWARD JACKSON.

Witnesses:
GEO. H. MAXWELL,
WILHELMINA C. HEUSER.

No. 770,431. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

INTERRUPTER.

APPLICATION FILED APR. 6, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

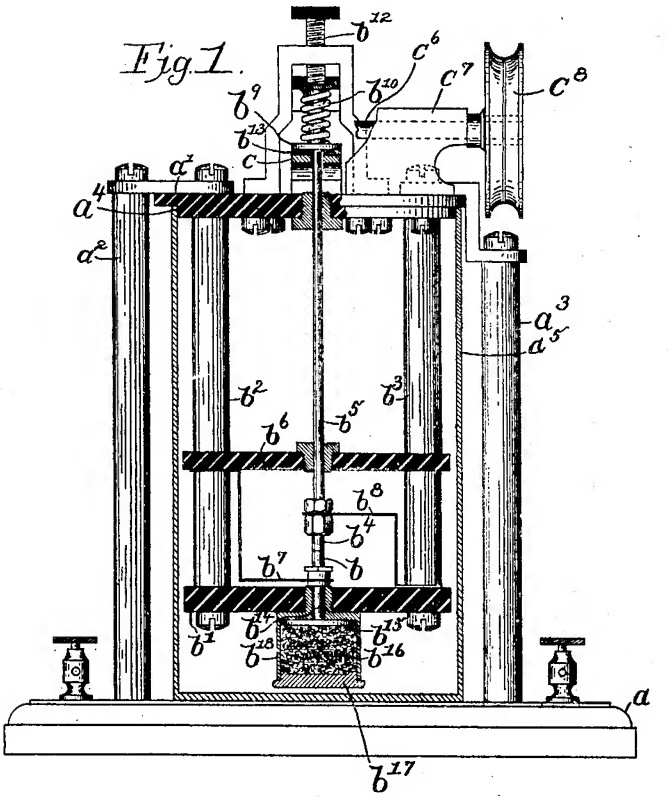
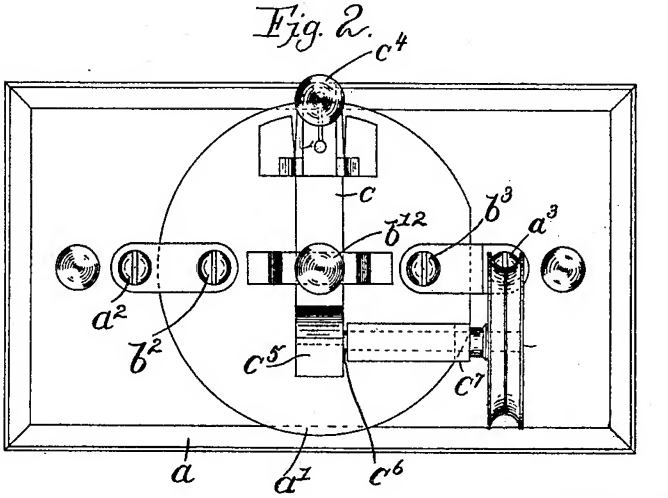


Fig. 2.



Witnesses.
Howard G. Davis.
M. L. Dellhommeau.

Inventor.
Thomas B. Kinraide,
by Geo. S. Maxwell
Atty.

No. 770,431. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

INTERRUPTER.

APPLICATION FILED APR. 6, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

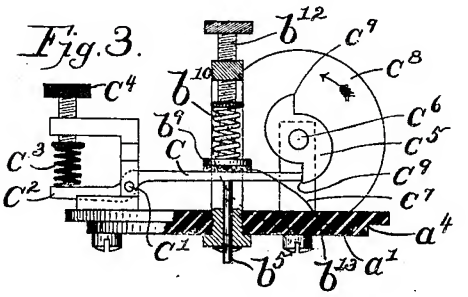


Fig. 4.

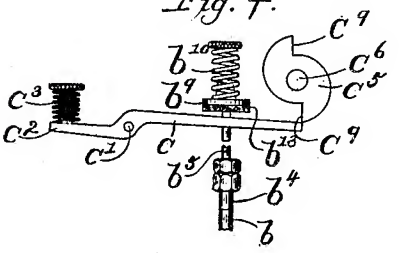


Fig. 5.

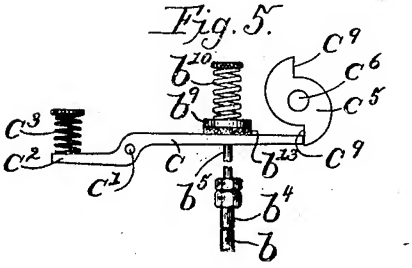
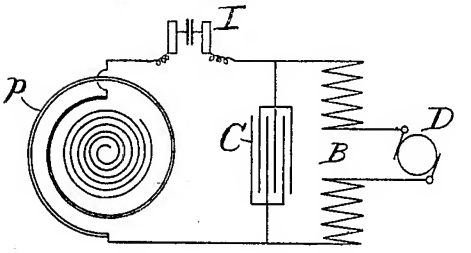


Fig. 6.



Witnesses.
Howard G. Davis.
M. L. Delhommeau.

Inventor:
Thomas B. Kinraide,
by Geo. H. Maxwell Atty.

No. 770,431. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF JAMAICA PLAIN, MASSACHUSETTS.

INTERRUPTER.

SPECIFICATION forming part of Letters Patent No. 770,431, dated September 20, 1904.

Application filed April 6, 1904. Serial No. 201,941. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Jamaica Plain, in the Commonwealth of Massachusetts, have invented an Improvement in Interrupters, of which the following description, in connection with the accompanying drawings, is a specification.

My invention is an improvement in interrupters, and has for its object the provision of means for obtaining a quick short break, the means for obtaining the same, as herein shown, being mechanical. In other words, the object of my invention is to cause a break for the least possible time and to keep the circuit closed the longest possible time, and to accomplish this result it is necessary as far as possible to do away with momentum, having no hammer as such, but providing a striking device operating against the tension of a spring suddenly released.

In my Patent No. 623,318, dated April 18, 1899, I have shown and described a "spark-gap" composed of plates one of whose functions is to receive a condenser discharge when properly adjusted, and one of the objects of the present invention is to obtain certain of the advantages of the aforesaid construction by means of an interrupter, and I obtain the same by having the separation of the electrodes so brief and sudden that the movable electrode returns just in time to take the condenser discharge and prevent the surging back of the impulse or wave from the condenser which would otherwise take place through the inductance-coil, but which by having the break short and quick (and the parts free of momentum) permits the gap to close in time to direct the condenser discharge through the primary of the induction-coil, and the break or gap can be so adjusted as to consume or receive all the condenser discharge as fast as conveyed to it, thereby preventing all surging back, and hence securing the greatest efficiency at the primary.

Various other advantages and further constructional details of my invention will be pointed out and the operation thereof will be fully set forth in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated a preferred embodiment of my invention.

In the drawings, Figure 1 is a central vertical section of one form of my interrupter. Fig. 2 is a top plan thereof. Fig. 3 is a fragmentary view in vertical cross-section, taken at right angles to Fig. 1. Figs. 4 and 5 are fragmentary details similar to Fig. 3, showing, respectively, the interrupter in position about to give a break and in position just causing a break. Fig. 6 is a diagrammatic view showing the circuit connections for which my interrupter is particularly adapted.

The main principle of my interrupter is that the break is caused by a striker propelled by a suddenly-released spring or by equivalent means, which causes the same to give a hammer-like blow, without, however, employing a hammer. The old interrupter employs a swinging hammer or momentum device and is practically limited in its operation to the momentum due to its weight, and this very weight also renders its action necessarily sluggish, which is further increased by the action of the electromagnet, which tends to hold the hammer until deënergized. Having premised this much, my invention will be readily understood from the following brief description.

Mounted on a suitable base a is a top plate or support, herein shown as a cap a', retained by posts a^2 a^3 and shouldered at a^4 to engage the upper end of an oil well or cup a^5, in which the separating contacts or electrodes are mounted.

As herein shown, the fixed electrode b is mounted in a cross-bar b', carried by two opposite rods or conductors b^2 b^3, and the movable electrode b^4 is carried by a rod b^5, slidingly mounted in a cross-bar b^6 and in the top plate a', conductor-wires or copper ribbons b^7 b^8 being connected, respectively, with the electrodes b b^4 and to the rods b^2 b^3. The rod b^5 has a shoulder or head b^9 at its upper end and is normally held in contact with electrode b by a spring b^{10}, whose tension is regulated by a thumb-screw b^{12}. Beneath the head b^9 is a striker c, shown as a light plate-metal arm pivoted, as at c', and having its rear end c^2 engaged by a spring c^3, whose tension is regulated by a thumb-screw c^4. The striker c is

freely movable toward and from the head b^9, a piece of felt or other cushioning material b^{13} being interposed for lessening the noise, and the end of the said striker projects forward into the path of an actuator, herein shown as a shouldered cam c^5, mounted on the end of a shaft c^6, journaled in a block c^7 and carrying at its opposite end a drive wheel or pulley c^8.

As the cam rotates in the direction of the arrow, Fig. 3, the parts first assume the position shown in Fig. 4, spring c^3 being strongly compressed and striker c moved back away from the head b^9 of the movable electrode or electrode-carrier, and thereupon further rotation of the cam permits the striker to escape from the shoulder c^9 thereof, and instantly spring c^3 causes said striker to deliver a sudden and severe blow against the head b^9, which instantly separates the electrodes; but as the force of the blow is spent the very moment it strikes the head b^9, there being no heavy swinging hammer or momentum device, the blow is given entirely by the suddenly-released spring, or, in other words, the mechanical actuator or cam that operates the striker does not deliver the blow, but the latter is brought about entirely separately from the cam by the suddenly-released spring. This will act to open a strongly spring closed pair of contacts, which could not be opened even by a heavy hammer, and yet it will do so with a quickness and to such a slight extent that the closing is almost instantaneous, and thereby accomplishes the short break and quick closing which is the principal object of the invention.

The chatter or noise of the contacts or electrodes b b^4 upon each other, due to the strong action of the spring b^{10}, is objectionable, and I have found that it can be almost entirely prevented by providing the supporting-rod b^{14} of the electrode b^7 with a head b^{15}, resting against a cushion, shown as consisting of a series of felt disks b^{16}, retained by a removable cap b^{17} in a casing b^{18}, supported on the under side of the plate b', so that as the blow of the movable electrode is delivered the noise is effectually prevented.

The operation of my invention will further be understood by reference to Fig. 6, where it will be seen that the interrupter I is contained in the circuit of a primary p of an induction-coil, the other end of the primary leading to an inductance-coil B and thence to a source of energy D, a condenser C being inserted across the circuit between the inductance-coils and the interrupter. With an old interrupter operating in the above system the action would necessarily be so sluggish as to obtain little efficiency, the discharge from the condenser surging back through the inductance-coils during the break or period of opening of the electrodes; but by reason of the extremely short and quick break made possible by my interrupter the discharge from the condenser is received by the movable electrode just as it is moving back into closed position, and this operation is repeated, so as to consume all the condenser discharge as fast as it is delivered.

In the preferred form of my apparatus, which I have described above, the cam c^5 releases the striker twice at each rotation, the force of the blow being determined by the adjustment of the striker-spring c^3, and the striker spends its force against the shoulder or head b^9, delivering the blow, however, against the felt buffer b^{13}, and instantly the spring b^{10} restores the contacts to closed position. In other words, the desired intense quickness of movement is due to the inertia of the contact and its spring and to the fact that when the thin light striker has delivered its quick-flying blow it instantly parts with its force, there being nothing to continue its impelling movement, as would be the case if it were weighted like a hammer, and therefore the result is that the instant the force of the striker is spent against the contact-head the high-tension spring of the latter closes the contacts again. The periodicity of movement thereof may be regulated by adjusting the tension of the spring so as to insure that the open interval corresponds to the time of the forward wave or impulse of the condenser.

As the electrode returns to closed position and strikes against the relatively fixed contact the noise is taken up or absorbed by the sound-deadening felt disks b^{16}, which are retained in the oil-tight casing b^{18}.

It will be understood that I have shown merely one of the many embodiments of which my invention is capable, the present embodiment being well adapted to continuous and hard usage; but I do not intend to limit myself to the constructional details herein set forth, excepting as otherwise required in the claims.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An interrupter, comprising separable contacts, means tending to maintain them closed, a striker for momentarily separating them, impelling means for imparting the striking movement to said striker, and an independent actuator therefor.

2. An interrupter, comprising separable contacts, a striker for suddenly moving one of said contacts, and a mechanical actuator for operating said striker.

3. An interrupter, comprising separable contacts, yielding means for maintaining them closed, and spring-impelled means for momentarily separating said contacts.

4. An interrupter, comprising separable contacts, yielding means for maintaining them closed, a striker having its striking end thin and light for reducing momentum effects to a minimum, a spring adapted to be compressed

and released for causing said striker to separate said contacts by the force of its impact, and means for releasing said spring.

5. An interrupter, comprising separable contacts, a striker having a thin, light, striking end, means consisting of a released spring for imparting a sudden striking impulse to said striker for separating said contacts, and means for instantly counteracting the separating effect of said striker and closing the contacts.

6. An interrupter, comprising separable contacts, a striker, means consisting of a released spring for actuating said striker to separate said contacts, and an oppositely-acting spring for instantly closing the contacts thus separated.

7. An interrupter, comprising separable contacts, a striker for separating them, and a cam-actuator for operating said striker.

8. An interrupter, comprising separable contacts, carrying means for one of said contacts provided with a shoulder or head, a cushion on the inner side of said head and a spring-impelled striker for acting against said cushion to separate said contacts.

9. An interrupter, comprising separable contacts, carrying means for one of said contacts provided with a shoulder or head, a cushion on the inner side of said head and a spring-impelled striker for acting against said cushion to separate said contacts, and a cushion bearing against the outer end of the other of said contacts.

10. An interrupter, comprising separable contacts, a striker for moving one of them, a cushion-holder provided with sound-deadening yielding material, and means carried by the other of said contacts for bearing against said materials and thereby deadening the sound of the closing of said contacts.

11. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts.

12. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts, consisting of a series of felt layers for receiving the closing impact of said contacts.

13. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts, an oil-well inclosing said contacts, and an oil-tight casing inclosing said sound-deadening means.

14. The combination with an induction-coil and condenser of an interrupter, comprising separable contacts, separating means and closing means therefor for giving a long closed period and an exceedingly short open period, and adjusting means coöperating therewith to give said contacts a periodicity of movement to receive and transmit the full condenser discharges.

In witness thereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

R. S. FORD,

JOHN E. PORTER.

No. 770,432. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

HIGH POTENTIAL INDUCTION COIL.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

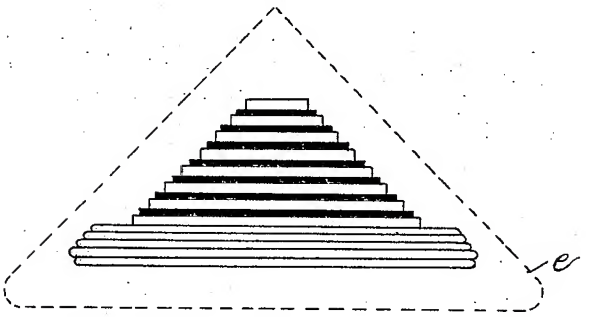


Fig 2.

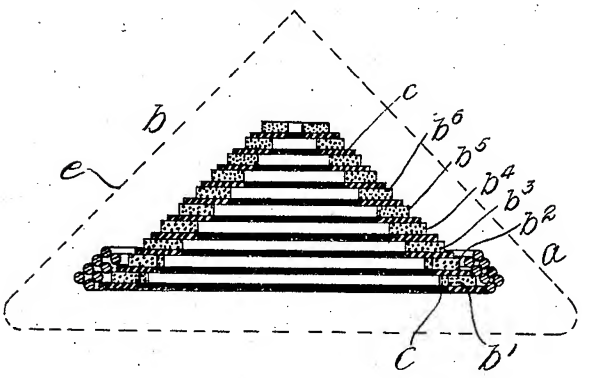
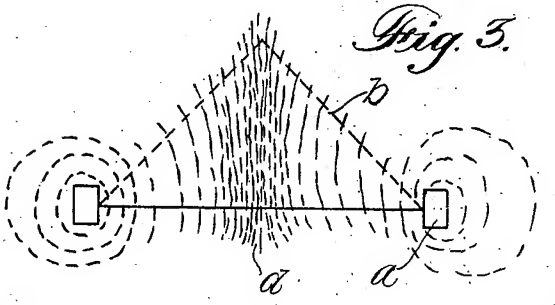


Fig. 3.



Witnesses:—
John E. Porter.
Alexander Lincoln

Inventor:—
Thomas B. Kinraide.
by Geo. H. Maxwell
Attorney.

No. 770,432. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-POTENTIAL INDUCTION-COIL.

SPECIFICATION forming part of Letters Patent No. 770,432, dated September 20, 1904.

Application filed May 25, 1904. Serial No. 209,684. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing in Boston, in the county of Suffolk, State of Massachusetts, have invented an Improvement in High-Potential Induction-Coils, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is an improvement in that kind of apparatus which I have patented heretofore and whose advantages and purposes are set forth in my Patent No. 615,653, dated December 6, 1898, the present invention having for its object the provision of means for greatly increasing the efficiency and capacity of the coil.

One of the main objects of my special kind of coil as outlined in the aforesaid patent is to obtain a unidirectional discharge or high voltage at the center, and for this purpose the turns are made successively shorter as they recede from the surrounding primary, or, in other words, the coil is helical for providing the constantly-decreasing resistance per turn, and in my present invention I avail myself of the same principle of construction, having, however, provided means for rendering it feasible to employ coarse wire of many turns, whereby the coil has low resistance, and hence higher frequency and higher voltage. I accomplish this object by winding the coil in the form of a cone, so that the windings overlap each other and gradually approach the center. When the windings are in a flat coil, it is obvious that the extent of wire is limited to that number of turns whose aggregate diameters of wire equal the diameter of the coil, because each turn must necessarily be within the adjacent turn, whereas by building the coil in the form of a cone it is possible to have the successive layers or turns overlap the preceding layers or turns and yet be successively shorter sufficiently to insure a unidirectional flow of the current or a tendency of the current to flow in one direction, due to the constantly-decreasing resistance of the successive portions of the coil.

My invention will be further explained as to its construction, operation, and advantages in connection with the accompanying drawings, in which I have shown one embodiment of my invention, and the latter will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a view in side elevation of the preferred embodiment of my invention. Fig. 2 is a vertical cross-sectional view thereof. Fig. 3 illustrates diagrammatically certain advantages thereof.

It will be understood that in the drawings I have not undertaken to show the complete mechanical embodiment or to illustrate the construction of the coil itself.

A coarse primary a of one or more turns is provided at the base of the coil, and from said base the secondary b is wound, being preferably wound in successive ring-like layers, the largest being indicated at b' at the base of the coil and thence extending diagonally upward, as indicated at b^2 b^3 b^4 b^5 b^6, &c., these successive layers being supported by insulator-rings c. This construction permits each successive turn or layer of secondary wire to overlap the preceding layer, and yet each successive layer is shorter, and therefore has less resistance, than the preceding layer. For example, b^2 overlaps b' and is overlapped by the layer b^3, so that although each layer may thereby have the same number of turns yet these turns can be composed of coarser wire than would be the case if all the layers were in the same flat plane with the layer b'. Also this construction brings the entire mass of secondary within the saturated field d of force, as indicated diagrammatically in Fig. 3. The decreasing resistance of the turns maintains the highest potential at the center, and the overlapping of the turns, and hence employment of coarse wire, still further decreases the resistance of the successive turns, so that the frequency and voltage are extremely high. The resistance of any secondary when operated from a condenser determines the frequency of the coil, and by my invention, which permits the employment of coarse wire, the resistance is reduced to a minimum. The angle or pitch of the cone will vary according to the conditions and purposes of use, and

ordinarily the coil will be inclosed in a suitable jacket and incased in wax, as indicated by the dotted line *e*.

My invention is capable of a wide variety of embodiments and an extended field of usefulness, being specially adapted for use wherever exceedingly high frequency is desired without liability of breaking down under severe usage.

While the employment of a long coarse-wire secondary wound as explained is of great value and an important feature of my invention, I do not restrict myself thereto, as the conical arrangement is of advantage for many purposes with fine wire, nor do I limit the invention except as otherwise required in the claims to the particular shape shown.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An induction-coil whose secondary is composed of a plurality of overlapping sections successively shorter as they recede from the primary.

2. An induction-coil having its secondary composed of a plurality of successively shorter sections of greater aggregate width than the diameter of the coil, thereby decreasing the resistance, for affording very high potential.

3. An induction-coil having a conical secondary.

4. An induction-coil comprising a primary and secondary, the latter having its successive sections, toward the center, of decreasing resistance, and having a plurality of the longer sections directly adjacent the primary.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
R. S. FORD.

No. 770,433. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

THERMAL INDUCTOR.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig 1.

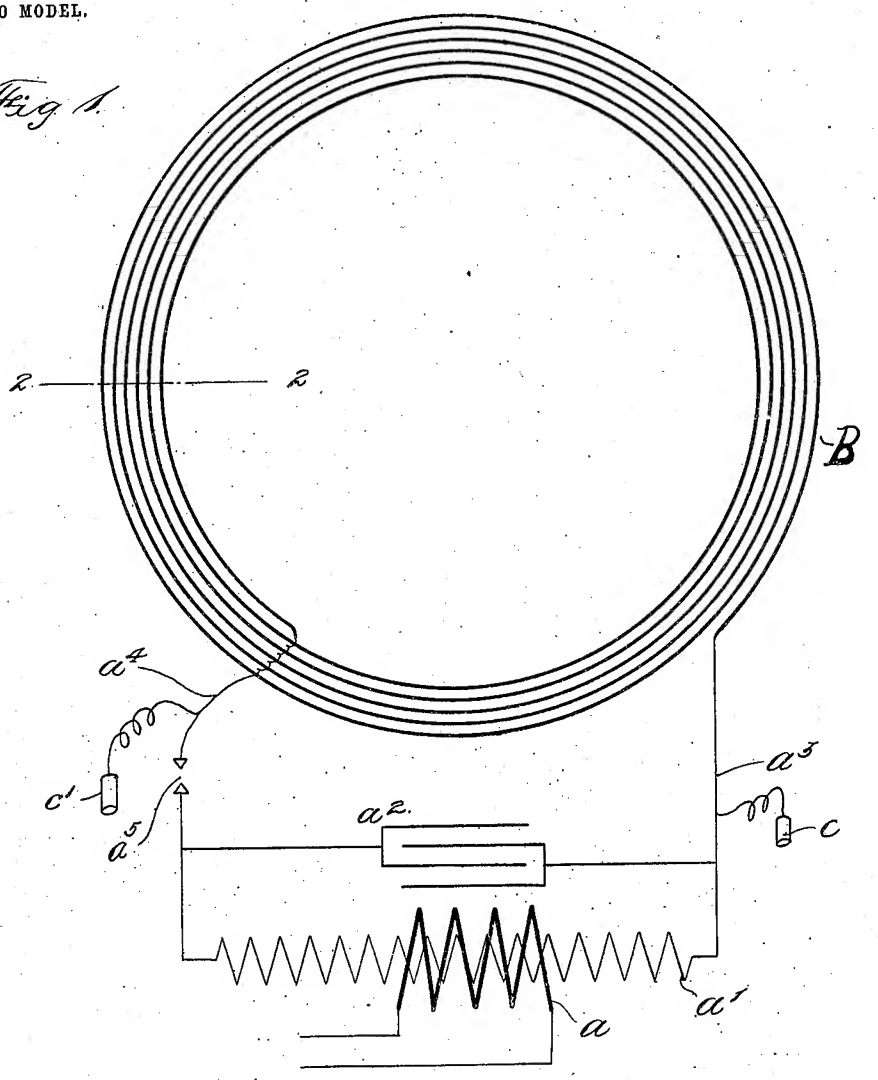
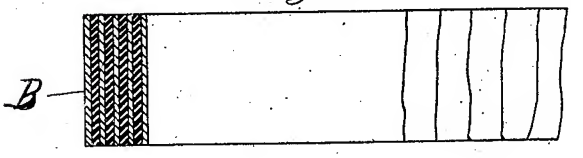


Fig. 2.



Witnesses:-
John E. Porter
A. M. Rice

Inventor,
Thomas B. Kinraide,
by Geo H Maxwell
Attorney.

No. 770,433. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

THERMAL INDUCTOR.

SPECIFICATION forming part of Letters Patent No. 770,433, dated September 20, 1904.

Application filed May 25, 1904. Serial No. 209,687. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented an Improvement in Thermal Inductors, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present invention is an electrical apparatus for therapeutical uses, the object thereof being to produce a high state of cell activity unaccompanied by the well-recognized, disagreeable, and unpleasant electrical phenomena usually attending the use of electrical apparatus.

I have discovered that it is possible to produce a peculiar heat effect, which is very advantageous in therapeutical treatment wherever sluggish conditions exist without producing any sensation of current passing through the body, but producing merely the sensation of heat. I accomplish this result by providing an electric filed of enormous frequency having very low self-inductive resistance per turn.

The structural arrangement and further advantages of my invention will be pointed out in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In the drawings, Figure 1 is a diagrammatic view thereof; and Fig. 2 is a vertical cross-sectional view taken on the line 2 2, Fig. 1.

In connection with a suitable high-frequency generator, herein indicated as comprising a high-potential transformer composed of a primary a and a secondary a', the latter leading to a condenser a^2 of small area, from which lead terminals a^3 a^4, a spark-gap a^5 being interposed in one or both of said terminals, being shown in a^4, I provide a special coil B, which, taken in connection with the aforesaid high-frequency generator, produces the peculiar thermal effect, with imperceptible current effect, which constitutes my discovery. This coil B, as clearly shown in Fig. 2, in which I have shown a practical working size thereof, consists of a thin wide ribbon of suitable conducting material, such as copper, formed in a coil having large diameter and few turns. For practical purposes I have found that a coil about eighteen inches in diameter composed of five turns of ribbon one inch wide used in connection with a condenser of small capacity is very efficient for accomplishing the results which I have discovered. Suitable hand-electrodes c c' are connected to the terminals of the coil as near to the condenser as convenient, as indicated in Fig. 1.

In use the terminals c c' are grasped by the hands of the patient, or if other forms of electrodes are used they are placed upon the body or manipulated in any manner desired by the physician, the result being that a gently-permeating heat effect suffuses the portions of the body adjacent the electrodes c c' without, however, being accompanied by any of the disagreeable and in some instances dangerous electrical effects which accompany the ordinary faradic current. There is no painful spark and no danger whatever from the current, so that it can be safely applied with a sponge without any danger of bad effects in removing or applying the same in a wet condition. The enormous high frequency produced by this special coil produces a bombardment in the molecular structure of the tissues, resulting in a mechanical heat effect, and yet as the resistance per turn of the coil B is extremely low in self-induction, there being scarcely any rise in potential from turn to turn, there is no appreciable electric effect present. The high state of cell activity produced by this apparatus manifests itself in various ways—as, for example, by the production of moisture on the surface and the reddening of the skin.

I do not intend to limit myself to the precise form, proportions, or arrangement herein described, as it will be readily understood by those skilled in the art that the invention is capable of a wide variety of embodiments.

Having described my invention, what I claim to be new, and desire to secure by Letters Patent, is—

1. A device of the kind described, comprising a source of high-frequency current includ-

ing a condenser of small capacity, and a coil in series therewith, consisting of few turns of large diameter and extremely low self-inductive resistance.

2. A device of the kind described, comprising a source of high-frequency current, in series with a coil of low self-inductive resistance per turn and having an inappreciable difference in potential between successive turns.

3. A device of the kind described, comprising a high-frequency generator including a condenser of small capacity, and a coil of large diameter and few turns of conductive material presenting large superficial conducting area, said coil being connected around said condenser, and a spark-gap interposed in one terminal.

4. A device of the kind described, comprising a source of high-frequency current, in series with a coil of large diameter and few turns composed of a wide, thin ribbon conductor.

5. A device of the kind described, comprising a source of high-frequency current, in series with a coil of large diameter, few turns, and low self-inductive resistance per turn, and an electrode connected to each terminal of said coil.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
R. S. FORD.

No. 774,758. PATENTED NOV. 15, 1904.

T. B. KINRAIDE.

ELECTRIC SPARK GAP.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

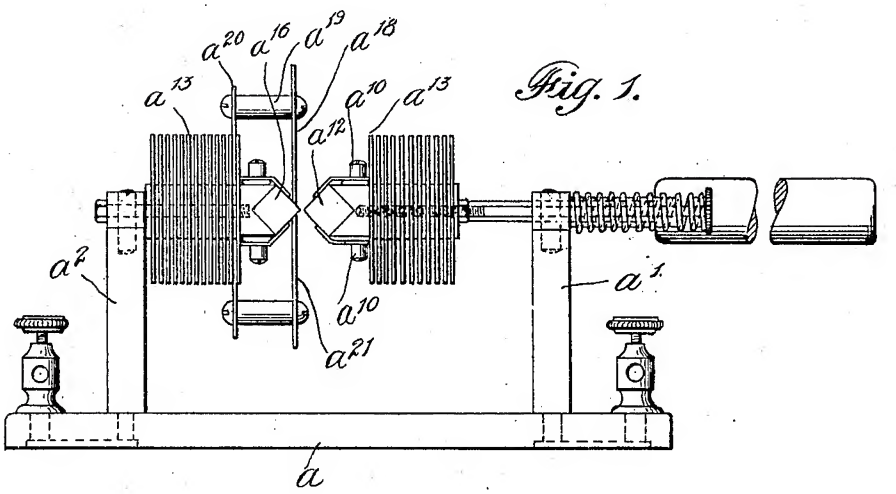


Fig. 2.

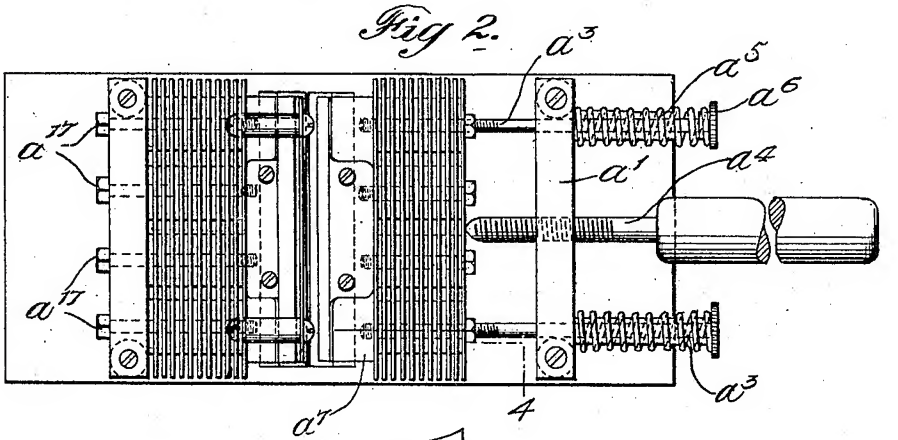


Fig. 3.

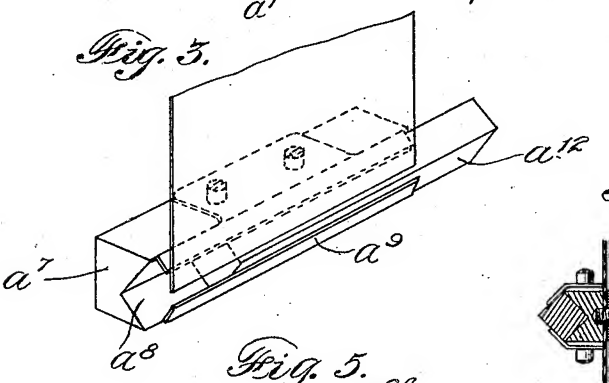


Fig. 4.

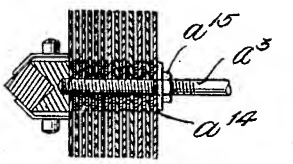
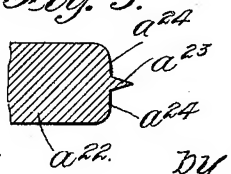


Fig. 5.



Witnesses,
John E. Potts.
Robert Ringrose.

Inventor,
Thomas B. Kinraide,
By Geo. H. Maxwell
Attorney.

No. 774,758. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRIC SPARK-GAP.

SPECIFICATION forming part of Letters Patent No. 774,758, dated November 15, 1904.

Application filed May 25, 1904. Serial No. 209,686. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented an Improvement in Electric Spark-Gaps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to spark-gaps intended particularly for high-frequency apparatus where great strain and constant action with a high-voltage current is required, my object being to provide a spark-gap capable of continuous service with uniform and economical action. One of the main difficulties encountered in this class of apparatus is that the heating effects are apt to cause a short circuit, thereby destroying the sparking effects and rendering them irregular in their action by tending to produce a continuous arc, due partly to the heated condition of the metal and partly to the heated air, which forms a good conductor between the two electrodes, and also the intense heating of the electrodes, especially at their points, tends rapidly to destroy them. Moreover, when used with an alternating current a point spark-gap is apt to be quite irregular and unsteady in its operation. Also the oxidizing of the metal causes serious interference with the continuous and proper operation of the usual spark-gap. My invention is to obviate all these disadvantages, as will be more fully pointed out in the course of the following description, where I have set forth in detail a preferred mechanical embodiment of my invention, and the latter will be more particularly defined in the appended claims, forming a part of this specification.

In the drawings, Figure 1 represents one embodiment of my invention in side elevation. Fig. 2 is a top plan view thereof. Fig. 3 is a fragmentary detail in perspective, showing one of the percussion-plates in place and illustrating the removable character of the electrodes. Fig. 4 is a transverse sectional view taken on the dotted line 4, Fig. 2. Fig. 5 is a transverse sectional view of a modified form of discharge-electrode.

Mounted on a suitable base a are opposite uprights or supporting-standards a' a^2 for supporting the electrodes which constitute the apparatus the standard a' supporting slide-rods a^3 and an adjusting-screw a^4, operating in opposition to springs a^5, held between the support a' and headed ends a^6, provided on the slide-rods a^3. The rods a^3 support at their forward ends an electrode-carrier a^7, herein shown (see more particularly Fig. 3) as having a slideway a^8 at its forward side and provided with overhanging retaining-clips a^9, removably secured to the carrier a^7 by set-screws a^{10}. Said clips a^9 and way a^8 constitute a receiving-passage and holder for a removable electrode a^{12}. At the rear of the electrode-carrier a^7 I mount a series of vertically-extending heat-separators a^{13}, spaced apart by any suitable means, herein shown as themselves threaded upon the slide-rods a^3 and held apart by intervening washers a^{14} and clamped in immovable relation by nuts a^{15}. Opposite the electrode a^{12} is a similar electrode a^{16}, removably retained in a similar holder, composed of clips and a carrier, the same as already described. The latter is supported on rods a^{17}, rigidly held in the rear standard or support a^2 and carrying separator-plates a^{13}, as in the case of the opposite electrode.

The electrodes proper or discharge-bars a^{12} are herein shown as square in cross-section, and the seats of the holders are correspondingly shaped, the purpose of this construction being to permit the parts a^{12} to be changed, one edge thereof being kept in use until worn away, and then the electrode is simply pulled out from its holder, given a quarter-turn, and inserted again with another corner or edge presented for active use. These removable parts a^{12} are preferably composed of hardened steel, so that the oxid whenever formed is at once burned off, whereas with copper and the baser metals a permanent film of non-conducting oxid is formed, which rapidly results in insulating the discharge-surface of the electrodes. A V-shaped edge gives the best results; but the bar may be varied from the triangular shape to cylindrical shape to suit different conditions.

Adjacent one of the electrodes herein shown

for convenience of illustration (and preferably so constructed for use) is a percussion-plate a^{18}, rigidly connected by bolts a^{19} to brackets or supporting-arms a^{20}, extending from the outer pair of rods a^{17}. Also, preferably, a similar percussion-plate a^{21} is mounted in vertical alinement with plate a^{18} to coöperate with the electrode a^{16}, on the under side thereof. These plates a^{18} a^{21} engage or are arranged close to the electrode a^{16}, slightly back from the point or edge thereof. If desired, similar percussion-plates may be employed on both electrodes, although for usual purposes the arrangement shown is sufficient and even one of the plates will ordinarily suffice.

The foregoing construction taken as a whole results in giving a uniform continuous action, the separators a^{13} serving to separate the heat effect from the electric effect, it being borne in mind that there is always present a heat effect which invariably accompanies the electric discharge, and the object of the separator-plates a^{13} is to separate these two effects, thereby confining the spark-gap discharge as nearly as possible to the electric effect solely and shunting the heat effect or separating it as developed from the electric effect as the discharge takes place between the points at the discharge-gap. This results in permitting a continuous disruptive discharge effect. Taken alone, however, it does not give uniformity of action with an alternating current, and to secure this result I provide the percussion-plate, as I have found that the main reason for unsteady and defective action in this particular is due to the fact that the alternations of the current interfere with each other and produce a bombardment at the spark-gap, resulting in a decidedly irregular sparking. I have also discovered that this irregularity of action can be entirely prevented simply by placing a plate slightly back from the discharge-point, the result being that it permits both alternations to spark across the gap. The plate simply destroys the arcing which is otherwise produced by the alternation of the current, and thereby enables the discharge to take place naturally and also make a much freer path for the discharge, permitting longer sparking.

I prefer to make the percussion-plates of copper, although other materials may be used. In Fig. 5 I have shown a construction in which the percussion-plate is embodied with the electrode as nearly as possible, (although the result is inferior to that secured by the construction above explained,) said figure showing an electrode a^{22}, having a discharge edge or point a^{23}, and adjacent thereto a plane surface a^{24}, serving very much the same purpose as the plates a^{18} a^{21}. The discharge-point a^{23} maintains a positive condition and the plane surface a^{24} a negative condition, the former constituting a discharge element and the latter a receptive area and coöperating with the point a^{23} to receive the bombardment or percussion and counteract the arcing, as above explained.

In use the alternating current passes from one electrode to the other across the gap with the utmost freedom under all conditions of stress, and the construction above explained in detail results in a steady and uniform discharge, removing all strain on the condenser by making a perfectly free and easy path for the discharge.

Besides the features of construction to which I have already directed special attention I wish to direct attention to the fact that the preferred embodiment of my invention herein disclosed provides an edge discharge of considerable length, thereby securing to a large extent the advantages more fully explained in my Patent No. 623,318, dated April 18, 1899.

It will be understood that while I have endeavored herein to comply with the law requiring a complete description of the best embodiment of my invention I do not intend to limit all my claims thereto and wish it understood that various features of my invention are applicable to other relations and that many changes in form, arrangement, and combination of parts may be resorted to without departing from the spirit and scope of my invention. For example, the main features of my invention are applicable to a point discharge-gap, and so likewise various features herein shown may be omitted and yet leave a construction capable of producing superior results over the ordinary spark-gap. I consider the removable feature of the electrodes as of considerable importance, the holder being slightly yielding for maintaining perfect contact and yet permitting the instant removal of the electrodes for the purpose of rotating them so as to bring a new edge into active position or for the purpose of replacing them with entirely new electrodes. Also the copper separator-plates or means of separating the heat effect from the electric effect of the discharge is of importance, as it prevents the overheating of the discharge electrodes. In other words, this part of the invention provides what might be termed a "cool" discharge instead of a hot discharge rapidly tending to produce an arc and also the "percussion-plates," as I term them, for taking the bombardment and preventing the colliding or interference of the alternating current, thereby giving a smooth uniform discharge. All these novel features conspire together to produce a continuously even and steady discharge. Besides these leading features I have in some of my claims claimed various specific constructional details.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric spark-gap, having opposite

discharge-electrodes, heat-separating means consisting of a series of thin members of heat-conductive material extending laterally outward and located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes.

2. In an electric spark-gap, having opposite discharge-electrodes, heat-separating means located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes, said means comprising a series of separated conductor-plates in heat-conductive circuit therewith.

3. In an electric spark-gap, having opposite discharge-electrodes, heat-separating means located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes, said means comprising separated parallel plates mounted rigidly in conductive contact with the apparatus.

4. An electric spark-gap, having heat-separators in the form of thin conductor-plates mounted rigidly thereon.

5. An electric spark-gap, comprising opposite electrodes having a series of thin conductor-plates held rigidly adjacent but out of contact with each other, and extending outwardly from the electrodes.

6. In an electric spark-gap, an electrode having a rigid carrier provided with yielding holding means, and a discharge-bar removably held thereby, said holding means springing firmly in circuit-closing contact flat against the sides of said bar for giving a large conducting area for transmission of current.

7. In an electric spark-gap, an electrode having a rigid carrier provided with yielding holding means, and a discharge-bar removably held thereby, said bar having its forward sides converging to form a discharge edge, and said holding means conforming in shape thereto.

8. An electric spark-gap, having adjustable electrodes provided with two opposite equidistant, continuous discharge edges extending parallel to each other longitudinally across the apparatus.

9. An electric spark-gap, having electrodes provided with discharge edges extending lengthwise, parallel to each other, one of said electrodes being slidingly mounted in a support at a plurality of points, and means for adjusting said electrode toward and from the other electrode.

10. An electric spark-gap, comprising opposite electrodes of conductive material, said material being disposed in mass adjacent the discharge-gap and having the conductive material at the rear thereof distributed in thin radially-extending plates, the whole electrode being secured rigidly together for giving intimate conductive contact to all parts thereof.

11. In an electric spark-gap, comprising opposite electrodes, a percussion-plate secured in close relation to one of said electrodes and slightly back from the point thereof.

12. In an electric spark-gap, an electrode having a metal percussion-plate, secured slightly back from the discharge-point thereof and extending laterally therefrom for producing an even, uniform discharge of an alternating current.

13. An electric spark-gap, having a percussion-plate mounted on opposite sides of its discharge-point slightly back from the point thereof, and extending transversely to the direction of discharge.

14. An electric spark-gap, having an electrode provided with a conductor-plate mounted in contact therewith, slightly back from the point of discharge for preventing improper action in discharging an alternating current.

15. An electric spark-gap, comprising opposite electrodes, having discharge edges extending lengthwise, parallel to each other, and a percussion-plate mounted transversely to the air-gap between said electrodes and adjacent thereto, as and for the purpose set forth.

16. An electric spark-gap, comprising opposite electrodes having discharge edges extending lengthwise, parallel to each other, and opposite percussion-plates, mounted transversely to the air-gap between said electrodes and adjacent thereto, said percussion-plates restricting the active area of the electrode to the edges thereof.

17. An electric spark-gap, having an electrode provided with a central discharge-point of small area and adjacent receptive portions of large area, of conductive material extending in planes approximately at right angles to the direction of discharge.

18. An electric spark-gap, having a gap formed by laterally-extended discharge parts, and a percussion-plate coextensive with said gap.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
R. S. FORD.

No. 774,759. PATENTED NOV. 15, 1904.

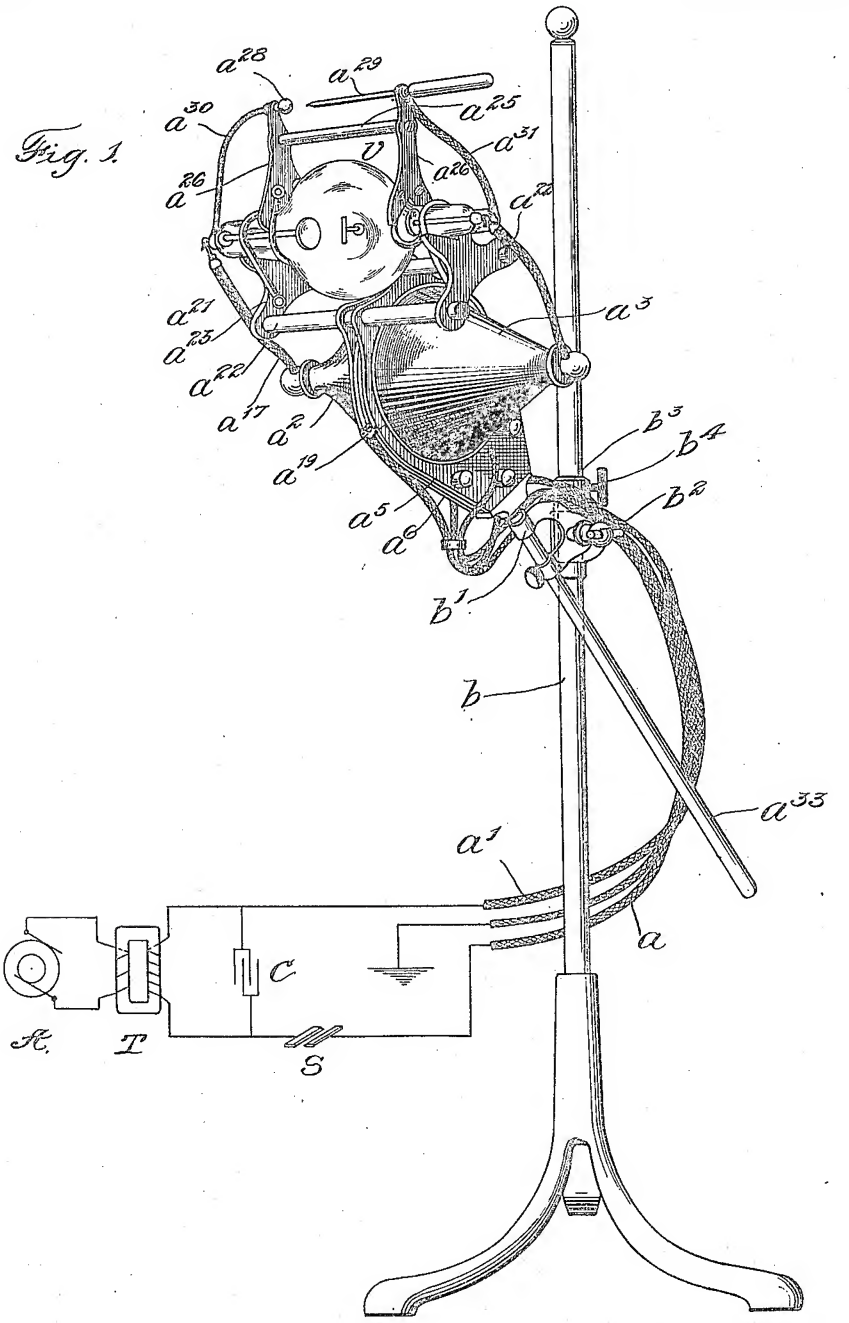
T. B. KINRAIDE.

PORTABLE HIGH FREQUENCY DEVICE AND VACUUM TUBE STAND.

APPLICATION FILED JUNE 27, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



Witnesses,
John E. Potts
Robert Ringrose.

Inventor,
Thomas B. Kinraide,
by Geo. H. Maxwell
Attorney.

No. 774,759. PATENTED NOV. 15, 1904.

T. B. KINRAIDE.

PORTABLE HIGH FREQUENCY DEVICE AND VACUUM TUBE STAND.

APPLICATION FILED JUNE 27, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

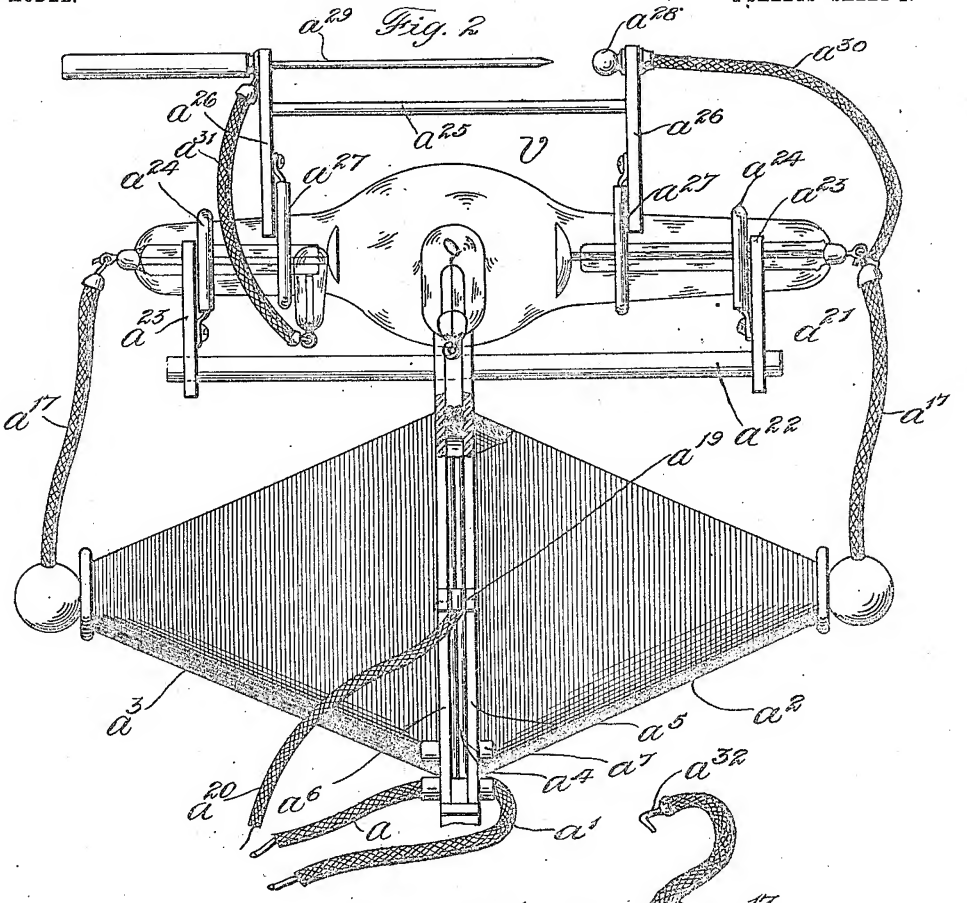
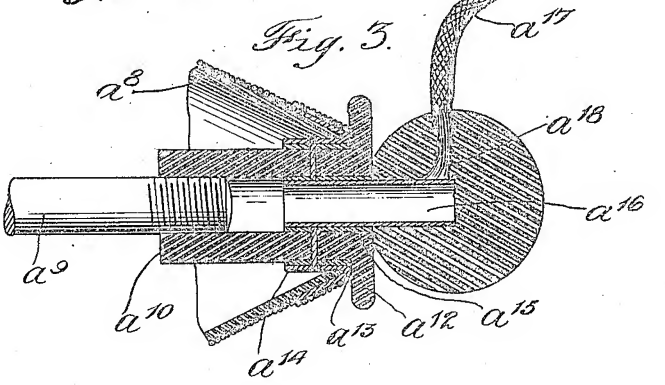


Fig. 3.



Witnesses,
John E. Porter.
Robert Ringrose.

Inventor,
Thomas B. Kinraide.
by Geo. H. Maxwell
Attorney.

No. 774,759. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

PORTABLE HIGH-FREQUENCY DEVICE AND VACUUM-TUBE STAND.

SPECIFICATION forming part of Letters Patent No. 774,759, dated November 15, 1904.

Application filed June 27, 1904. Serial No. 214,266. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, Massachusetts, have invented an Improvement in Portable High-Frequency Devices and Vacuum-Tube Stands, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an apparatus for enabling a vacuum-tube or the like to reach the highest efficiency in connection with high-frequency currents of high potential, my invention being particularly intended for therapeutical purposes.

The transmission of high-potential currents along long conductors is very wasteful. For instance, in the ordinary static machine the transmission from the machine to an X-ray tube causes a loss of considerably over fifty per cent., and it is well known that high-potential current is very difficult to transmit without a great loss by atmospheric conduction, and this is still more true of high-frequency alternating current, the difficulty being greatest, and hence the waste of current greatest, with the strictly high-frequency currents of induction apparatus. The loss, and hence the difficulty of transmission, increases with the increase of frequency, so that in therapeutical work (for which my invention is particularly adapted, as above mentioned) it becomes practically impossible to transmit the effects from the ordinary high-frequency apparatus to the patient or other object, even ten feet of the best insulated conductor practically dissipating the output. The result is that the so-called "high-frequency" apparatus falls far short of producing proper high-frequency results. Another serious objection resulting from the transmission of this high-potential current over long conductors (as heretofore necessary) is the danger to the patient, apparatus, and operator from the heavily-charged conductor-wires, and hence requiring great skill in their handling and a constant nervous strain upon the operator in doing so.

My invention has for its objects the obviating of the aforesaid difficulties and objections by providing an apparatus which can be operated without any danger to the patient or anxiety on the part of the operator, requiring little skill or technical knowledge in its use, working with very slight dissipation of current, and at the same time not being liable to break down or give out with careless handling. Besides, my invention provides a superior current and is attractive in appearance and convenient to manipulate.

Stated broadly, my invention, so far as it relates to the avoidance of loss of current, resides in mounting the X-ray tube directly on the secondary itself, thereby eliminating the usual conductors, inasmuch as the terminals of the secondary are directly connected with the terminals of the X-ray tube, and that feature of my invention which resides in its convenient portability consists in operating the high-frequency induction device—*i. e.*, the induction-coil, resonator, or the like—at a distance from the high-frequency generator, so that all the heavy portions of the apparatus remain stationary, while the induction device and tube are mounted together for direct use wherever required.

Other features of my invention and the various constructional details of the invention in its embodiment as herein shown will be pointed out in the course of the following description.

In the drawings, in which I have shown one only of many embodiments of my invention, Figure 1 is a perspective view thereof. Fig. 2 is a view in elevation looking at the rear side of the apparatus as shown in Fig. 1. Fig. 3 is an enlarged sectional detail showing the construction of one of the terminals of the apparatus.

This invention relates to high-frequency apparatus of the most advanced type, and by the terms "high frequency" and "high potential" as herein used I refer to currents capable of producing a disruptive or brush discharge into the air from spherical electrodes at least one inch to one and one-half inches in diameter, or, defined otherwise, my

invention relates to currents which cannot be conducted (at least not in the usual manner) over a conductor-wire, as commonly practiced with ordinary currents, but will dissipate themselves in the air in spite of any usual insulation. This high-frequency high-potential current because of the impossibility of conducting it has heretofore been incapable of practical and successful use for such purposes as those hereinbefore mentioned, because almost entirely lost in the air before reaching the translating device, (at the patient, for example,) said dissipation being, moreover, exceedingly dangerous to the operator; and it is the object of my invention to render available without danger or loss of current the kind of current which I have just defined. I have succeeded in securing the desired result, not by rendering the current any more transmissible than before, but by separating the essential parts of the apparatus in such manner and providing such construction that the exceedingly high frequency and high-potential current, with its attendant danger and difficulty, need not be transmitted, but is developed directly at and in connection with the portable translating device operated by a stationary and remote generating source comprising the heavier and more cumbersome portions of the apparatus, which are capable of transmitting without danger to the portable portion the proper current for operating the latter to produce the dangerous and non-transmissible current first defined.

The high-frequency generator or source of high-frequency current may be of any usual or preferred kind, being herein diagrammatically represented as comprising an alternator A, transformer T, condenser C, spark-gap S, (the latter being indicated as of the kind contained in my application Serial No. 209,686.) From this source of high-frequency energy conductors $a\ a'$ lead to the "tube-stand," (by which term I mean to include any device carrying the vacuum-tube or other translating device.) As herein illustrated said tube-stand is mounted for convenience on a standard or rod b. As already stated, the tube-stand consists of a "high-frequency" device, (by which term I mean to include any device capable of high-frequency discharge,) and, as herein shown, this high-frequency device is composed of two conical secondaries $a^2\ a^3$, extending coaxially in opposite directions from a common primary a^4. The general construction and advantages of the conical form of secondaries are set forth in my copending application, Serial No. 209,684, filed May 25, 1904. While I do not limit my invention to any definite use or capacity, a convenient construction includes a coarse winding of four turns, whose terminals connect to the respective conductors $a\ a'$, and a fine winding of No. 30 triple-wound secondary.

The bases of the secondary coils are arranged adjacent to each other and separated from the common primary a^4, wound in a peripheral groove formed between plates $a^5\ a^6$ and held in rigid position by suitable means, as bolts a^7. These secondaries are wound on hollow insulating shells or supports a^8 and held together by a tie-rod a^9 passing through the plates $a^5\ a^6$ and having threaded engagement at its ends with opposite ferrules a^{10}, (one only being shown in Fig. 3, as the construction is the same at the opposite ends of the apparatus,) whose heads a^{12} engage the outer ends of the cones a^8, thereby clamping the high-frequency device together. At their smaller ends each cone is provided with a conductor-plate a^{13}, connected by a pin or strip of conductive material a^{14} to a contact-plate a^{15} for tightly receiving a metal sleeve or post a^{16}, to the outer end of which is soldered or suitably secured the secondary-terminal a^{17}, as indicated at a^{18}, within a ball of insulating material. The opposite terminals of the two secondaries are connected together, as indicated at a^{19}, and grounded by a wire a^{20}.

The plates $a^5\ a^6$ carry a frame a^{21}, shown as comprising a pair of rods a^{22}, supported in said plates, and end supports a^{23}, notched at their upper ends, as plainly shown in Fig. 1, for receiving the vacuum-tube V or other translating device operated in connection with the apparatus. In the drawings I have shown one well-known form of X-ray tube as mounted in the frame a^{21}, said tube being held in position by heavy rubber straps a^{24}, connected at their free ends to the supports a^{23} and passed yieldingly about the ends of the vacuum-tube. On the latter is a bridge-frame consisting of a rod a^{25} and inverted-Y supports a^{26}, held in place by heavy rubber straps a^{27}, similar in construction and arrangement to the straps a^{24}. This bridge-frame carries opposite electrodes $a^{28}\ a^{29}$, connected by wires $a^{30}\ a^{31}$ to the vacuum-tube for regulating the vacuum therein in well-known manner. The opposite secondary-terminals a^{17} are provided with hooks a^{32} for quick connection with the translating device.

The tube-stand is provided at its lower end with a handle a^{33}, shown as slidingly mounted in a bracket b', adjustably secured by a hand-screw b^2 to a slide b^3, clamped by a thumb-screw b^4 to the standard b.

In use it will be seen that, in the first place, the X-ray tube is mounted directly on the high-frequency device instead of being mounted at a distance on a separate stand, as has heretofore been the practice. By this means separate conductors are entirely eliminated, it being necessary merely to extend the terminals proper of the high-frequency device the short distance required in order to reach the translating device, mounted as close thereto as the shape of the respective parts will permit. By this means the energy of the high-frequency device is not dissipated, but is directly

transferred to the X-ray tube, thereby giving an efficiency hitherto not obtainable. In the next place, the high-frequency device is light and portable, inasmuch as the heavier parts of the apparatus are separated therefrom, being ordinarily kept in a heavy cabinet considerably removed from the operating chair, table, or, it may be, from the room itself.

By the arrangement of the mechanism herein set forth as the preferred embodiment of my invention one primary serves for two secondaries, and also by having the secondaries arranged as shown, in which a single layer of fine wire is provided, the liability of sparking from turn to turn is eliminated and the discharge-terminal is removed from the primary, the resistance decreases with each turn, and it is possible to get more turns than in any other form with a single layer, &c., as explained in my before-mentioned conical-coil application.

The yielding holders a^{24} a^{27} permit the translating device to be turned readily without disarranging the connections, as has heretofore been necessary.

As already intimated, I do not intend to restrict myself to the precise construction herein set forth as the preferred embodiment of my invention, as many changes in form, arrangement, and relation of parts may be resorted to without departing from the spirit and scope of my invention as defined in the broader claims hereinafter contained. I regard my invention as broadly new in a number of particulars, as will appear more definitely in the following claims.

My invention has no relation in any way to low-frequency hand devices and portable cabinets operated by primary batteries and the like nor to the induction devices which were commonly used in connection with ordinary currents a few years ago, but is restricted to that class of apparatus, as previously defined, of which the current is of such a high frequency and high potential as to be practically non-transmissible, for the reasons already stated, over a usual conductor, said current having a high frequency and high potential capable of a disruptive brush discharge, as already stated.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The herewith-described means of rendering the described kind of current available with the highest efficiency directly at the point of use, consisting in the combination of a stationary generating source of high-frequency current, with an independently mounted and inclosed device capable of developing therefrom a high-potential and high-frequency current of the kind described, said device being capable of hand manipulation for direct application of said current and connected to said stationary source by a long flexible conductor permitting it to be readily moved about the room or patient without disturbing said stationary source.

2. The combination with a stationary source of high-frequency current, of a portable induction-coil operating in connection therewith to develop high-frequency high-potential current of the kind described, and a long flexible conductor supplying current from said source to the primary of said coil.

3. A high-frequency apparatus having a high-potential high-frequency disruptive discharge device movable independently of the rest of the apparatus for permitting local application or the like.

4. In an apparatus of the kind described, comprising a source of high-frequency current, and remote high-frequency device operated thereby, and a frame carried by said device for supporting a translating device in close proximity thereto.

5. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, having a central partition, terminals at the opposite sides of said partition, a frame carried by said partition transversely thereof for supporting a translating device, and means for connecting the latter directly with said terminals.

6. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, a flexible conductor engaging the two, means for connecting the terminals of said high-frequency device directly to a translating device, and means for moving said translating device and high-frequency device together.

7. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, a flexible conductor engaging the two, means for connecting the terminals of said high-frequency device directly to a translating device, and a handle extending from said high-frequency device for adjusting and moving the same and said translating device together.

8. A high-frequency device, comprising a primary, and a pair of independent secondaries operated by said single primary.

9. A high-frequency device, comprising an intermediate coarse primary, and opposite fine secondaries, operated thereby, having their discharge-electrodes remote from said primary.

10. A high-frequency device, comprising a primary, and opposite conical secondaries.

11. A high-frequency device, comprising a conical support, a secondary wound thereon, a peripheral groove at the base of said support, and a primary held in said groove.

12. A high-frequency device, comprising a primary, insulating-plates on opposite sides thereof, opposite secondaries outside of said plates, and retaining means therefor.

13. A high-frequency device, comprising a primary, retaining-plates therefor, opposite

conical secondaries extending coaxially in opposite directions therefrom, and an axial tie-rod binding all of said parts.

14. A high-frequency device, comprising a primary, a conical secondary operated thereby, a tie-rod, a ferrule binding said parts together, said ferrule having external and internal contact-plates electrically connected together and with said secondary.

15. In a high-frequency device, a conical secondary, having a discharge-terminal consisting of a ferrule having an internal contact-plate electrically connected with the smallest turn of said secondary, a removable conductor-post fitting against said contact-plate and having, adjacent the end of said ferrule, a short terminal wire permanently secured thereto.

16. In a high-frequency device, a conical secondary, having a discharge-terminal, consisting of a ferrule having an internal plate electrically connected with the smallest turn of said secondary, a removable conductor-post fitting against said contact-plate and having, adjacent the end of said ferrule, a short terminal wire permanently secured thereto in a ball of insulating material.

17. A high-frequency device, having a frame mounted directly thereon, and provided with means for securing a vacuum-tube thereto.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

E. G. PROCTOR.

No. 774,760. PATENTED NOV. 15, 1904.

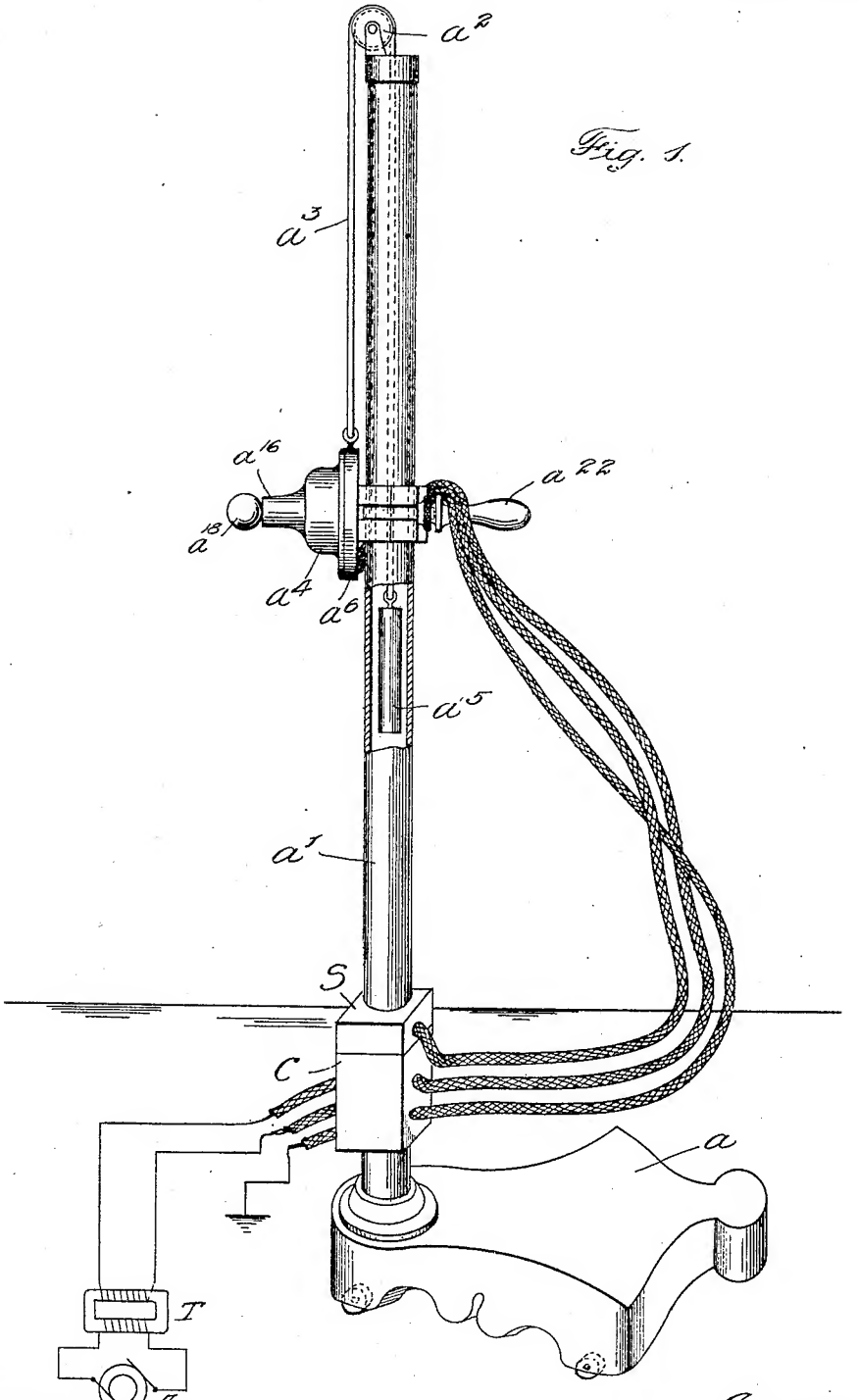
T. B. KINRAIDE.

SELF CONTAINED HAND ELECTRODE.

APPLICATION FILED JULY 5, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



Witnesses,
John E. Porter.
Robert Ringrose.

Inventor,
Thomas B. Kinraide.
by Geo. H. Maxwell
attorney.

No. 774,760. PATENTED NOV. 15, 1904.

T. B. KINRAIDE.

SELF CONTAINED HAND ELECTRODE.

APPLICATION FILED JULY 5, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

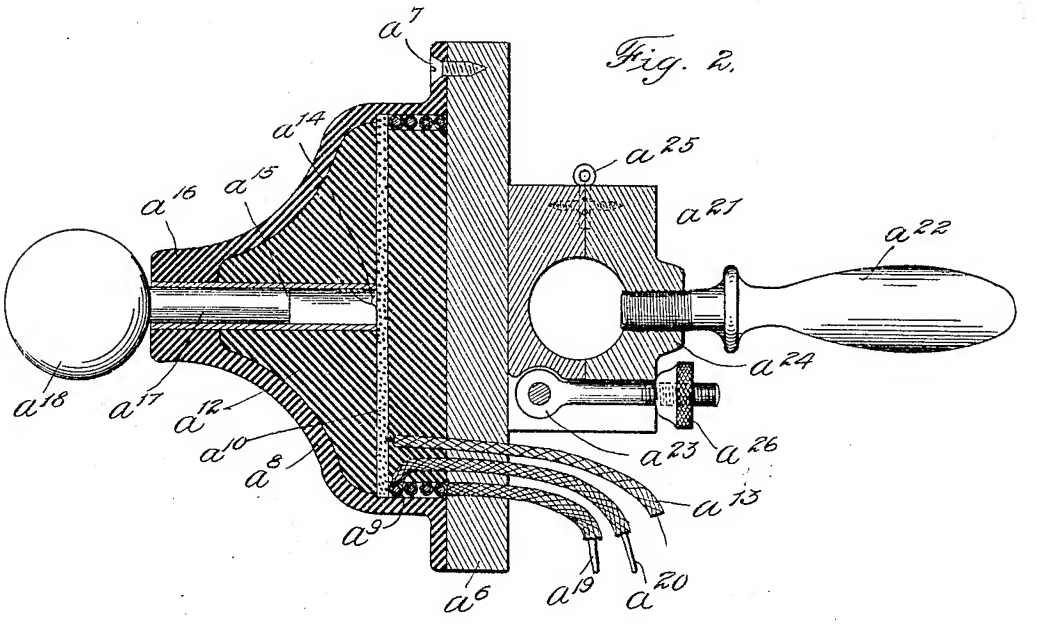
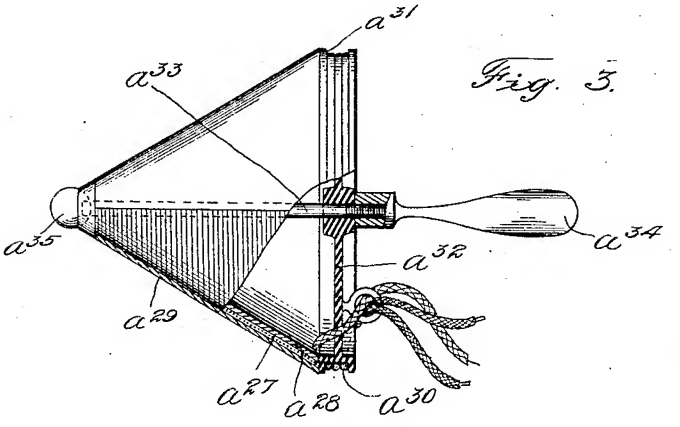


Fig. 3.



Witnesses
John C. Porter.
Robert Ringrose.

Inventor.
Thomas B. Kinraide.
by. Geo. S. Maxwell
Attorney.

No. 774,760. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

SELF-CONTAINED HAND-ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 774,760, dated November 15, 1904.

Application filed July 5, 1904. Serial No. 215,278. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, Massachusetts, have invented an Improvement in Self-Contained Hand-Electrodes, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The value and importance of electricity in the treatment of disease have recently gained wide recognition, especially in connection with the employment of high-frequency current. One serious difficulty, however, has been the adaptation or provision of means for rendering it practicable to employ very high frequency currents for local application. One difficulty has been the danger or discomfort likely to attend the application of this kind of current, and another difficulty has been the loss of current due to the action of atmospheric conduction on the conducting-wires leading from the high-frequency device to the patient, and a third serious difficulty has resided in the cumbersome apparatus, it having heretofore been necessary to move the entire generating apparatus to the patient or else move the patient to the apparatus.

It is the object of my present invention to obviate all these difficulties, besides providing various other advantages. I accomplish my object by providing a high-potential high-frequency disruptive discharge device operated by hand and readily movable independently of the generating source of the high-frequency current, so that the operator can manipulate the hand device the same as he has heretofore manipulated the usual hand-electrode and can now do so with my invention without the danger, inconvenience, or loss of current heretofore experienced.

The preferred form of my invention which I have herein shown is especially adapted for prolonged application as a head-terminal or for use above the patient, and I have also shown a form of my invention adapted for short and general application and for delicate manipulation and difficult cases of local application.

In the drawings, Figure 1 is a view in side elevation of one form of my invention. Fig. 2 is a transverse sectional view thereof on the line 2 2, Fig. 1. Fig. 3 is a view in side elevation of a modified form, parts being broken away for clearness of illustration.

One of the distinctive features of my present invention is the provision of a hand-electrode constituting in itself a high-frequency device, Figs. 1 and 2 showing the same as capable of being moved by hand up and down on a standard or removed therefrom and handled separately and Fig. 3 showing a lighter form of device for hand use only.

I wish it understood that my invention is restricted to high-frequency high-potential current of the kind previously mentioned, by which I mean current of such enormous frequency and high potential that it cannot readily be conducted because of its tendency to discharge into the air in spite of any usual insulation, my invention residing in providing means whereby that portion of the apparatus which is to be carried or moved by the hand of the operator is separated from the rest of the apparatus and contains within itself that portion of the winding or other mechanism which serves to transform the high-frequency transmissible current into the kind of current which is not transmissible and which I have defined as a high-frequency high-potential disruptive discharge-current.

On a suitable base a is rigidly secured a hollow standard a', provided with a pulley a^2, swiveled at its upper end, over which passes a cord a^3, carrying a hand-electrode high-frequency device a^4 at its outer end and a counterbalance-weight a^5 at its inner end.

The electrode a^4 comprises a back piece a^6, to which is secured at a^7 a shell of hard rubber or the like a^8, containing a coarse primary a^9, wound adjacent the outer turns of a flat secondary a^{10} of the form shown in my patent, Serial No. 615,653, of December 6, 1898, all embedded in insulating material, such as hard wax a^{12}, poured therein in melted condition. One terminal, a^{13}, of the secondary is shown as grounded, and the other or inner terminal, which constitutes the high-potential discharge-terminal of the secondary, is connected at a^{14} to a tubular contact device a^{15}, per-

manently secured in the pointed end a^{16} of the high-frequency device for receiving any desired form of discharge-electrode, the shank a^{17} of a ball-discharge electrode a^{18} being herein shown as mounted therein. The terminals of the primary are connected by suitable flexible conductors a^{19} a^{20} to a suitable source of electrical energy, shown as comprising a generator A of alternating current, whose conductors lead to a transformer T, connecting with a condenser C and spark-gap S. In my copending application, Serial No. 214,266, I have explained more at length the advantages of having the high-frequency device separated from the generating source, and in the present arrangement I have separated the parts still farther, the alternator and transformer, which serve to generate the low-frequency high-voltage current and which constitute the heavier portions of the generating apparatus, being separated a long distance from the movable portion of the apparatus, and the condenser and spark-gap, which serve to raise the low-frequency current to a high-frequency current, being mounted, preferably, directly on the standard a', thereby bringing as near to the discharge-electrode as practicable all that portion of the current which has any tendency to dissipate itself in the atmosphere by conduction. This also brings all the adjustable parts of the apparatus directly to the hand of the operator.

The arrangement as thus described is of great importance in therapeutical work, because it makes it possible to use the highest frequency and most powerful and efficient current without deterioration wherever it is desired to quickly shift the electrode, as the surgeon can readily move the standard a' here and there about the room without any inconvenience, the heavy generating parts being connected by long conductors and located in a closet or other convenient place, and as the operator is using the apparatus he can instantly adjust the hand-electrode up or down or sidewise and likewise adjust the spark-gap or condenser, all without leaving the patient or otherwise interrupting the treatment.

The back a^6 of the high-frequency device is provided with a clamp a^{21} and operating-handle a^{22}, said clamp being shown as consisting of two blocks a^{23} a^{24}, hinged at a^{25} and locked together by a thumb-nut a^{26}, although I do not restrict myself in any way to the means which may be provided for retaining the high-frequency device movably upon its standard.

From the above description it will be understood that the high-frequency generator may be located in the corner of the room or elsewhere, as desired, transmitting the current generated thereby to the high-frequency device over the conductors a^{14} a^{20} without danger or material loss of current, inasmuch as the form of the current as delivered from the source mentioned is of such well-known character that it is readily restrained by the ordinary insulation provided with good conductor-wires. The current having been delivered properly to hand-electrode a^4, which I have denominated the "high-frequency device," is raised by the latter to the enormous frequency and high voltage required for the disruptive discharge desired in this class of apparatus, and by my invention the high-frequency device itself is the electrode and is movable directly to the position required for local application. The truck or standard is readily moved to the operating-table or wherever required, and the hand device is swung on the rod a' to any direction desired and is readily raised or lowered. This, for instance, enables it to be used with a head-terminal for prolonged application, which would otherwise be practically impossible with the ordinary apparatus because of the fatigue resulting to the operator, whereas by my invention the operator is relieved of all fatigue and also the element of danger, and hence nervous anxiety on the part of the operator is practically eliminated, inasmuch as there are no conductor-wires from the high-frequency device, (which have heretofore constituted the source of danger.)

In case the application of the high-frequency disruptive discharge is to be of short duration, and especially if the application is to be with reference to an awkward position, the operator simply unclamps the device a^4 from its standard and holds it in his hand to the spot desired. For the latter purpose I also provide a lighter form of construction, as shown in Fig. 3, where it will be seen that I have provided a conical secondary a^{27}, wound on a light supporting-shell a^{28}, and preferably inclosed by an outer cone a^{29}, the primary a^{30} being wound in a peripheral recess or groove a^{31}, provided in a base a^{32}, the parts being held together in any desired manner, as by a rod a^{33}, having threaded engagement with the handle a^{34} and adapted to receive any kind of a discharge-electrode at its opposite end, as a ball a^{35}. This form of hand device is light and well adapted to general use and lends itself to more delicate manipulation than the heavier form of hand devices previously described.

It will be understood my invention is capable of a wide variety of embodiments, as I believe it is broadly new to provide a hand device or electrode which itself produces the high-potential high-frequency current that causes the disruptive discharge delivered by the electrode.

The current supplied to this hand device or hand-electrode is a high-frequency current, but is not of that quality which renders it dangerous and practically non-transmissible, the mechanism which transforms said current into the latter kind of current being contained within the electrode itself, whereby all necessity for further conductors, and hence

loss of current and danger, &c., are eliminated, the current not being permitted to assume this condition until it reaches the device which is to be carried or manipulated by the operator directly at the applying-point. I have already pointed out that the current to which my invention relates is not the ordinary current, and I wish to repeat that my invention relates to the most advanced type of high-frequency current known to therapeutical practice at the present day, being distinguished by its ability to produce a disruptive or brush discharge into the air from spherical conductors of one inch to one and one-half inches in diameter. I take this means of defining the character of the current, although it will readily be understood that it can be recognized by various other distinctive features and characteristics, and accordingly I do not intend to restrict myself by these definitions to any arbitrary frequency or potential, but have undertaken merely to explain the field of usefulness and kind of current with sufficient clearness to enable those skilled in the art to apprehend with certainty what my invention is, the difficulties it is intended to overcome, and the advantages effected thereby.

I am aware that it has long been common to employ hand-electrodes; but so far as I am aware these have either been remote from the producer of the form of current discharged or else they have not been capable of delivering the kind of discharge herein provided for. It will therefore be understood that I am not restricted in any way (excepting as specified in the claims) to the constructional details herein set forth.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A hand device or electrode for hand manipulation at the point of application, comprising a portable inclosure provided with a carrying device adapted to be grasped by the hand, said portable inclosure adapted to be connected to a source of high-frequency current, and containing within itself means for developing from said current a high-frequency high-potential disruptive discharge-current of the kind described.

2. A source of high-frequency current, and portable means for producing therefrom a high-potential high-frequency disruptive discharge-current of the kind described, said means being connected to said source by a long flexible conductor and being light in weight and small in size for carrying by hand and for hand application and manipulation.

3. A standard, provided with a hand-electrode movable up and down on said standard and containing a high-frequency induction device.

4. A portable standard or support, carrying a disruptive discharge-electrode provided within itself with a high-potential high-frequency coil.

5. A portable standard or support, carrying a disruptive discharge-electrode provided within itself with a high-potential high-frequency coil, said electrode being freely movable by hand with relation to said standard.

6. An electrode, containing an induction-coil, a hollow support therefor, on which said electrode is freely movable, and counterbalancing means within said support for said electrode.

7. A high-frequency induction device for therapeutical work, comprising a portable standard, a hand-electrode, containing a high-frequency high-potential induction-coil, mounted movably on said standard, and a generating source comprising a source of alternating current, transformer, condenser and spark-gap, the latter two being mounted on said portable standard and having a short connection to said hand-electrode, and said transformer and source of alternating current being remote from said standard.

8. A high-frequency induction device for therapeutical work, comprising a portable standard, a hand-electrode containing within itself means for producing from an ordinary high-frequency current a high-frequency, high-potential disruptive discharge-current, a condenser and spark-gap in the circuit thereof, mounted adjacent thereto, and a remote source of current therefor including a transformer.

9. In an apparatus in the kind described, a stationary alternator and transformer located remote from the rest of the apparatus, and a high-frequency translating device, spark-gap and condenser located close to each other connected by short conductors for operation in connection with said remote alternator and transformer.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

E. G. PROCTOR.

No. 785,671. PATENTED MAR. 21, 1905.

H. JACKSON.

DETONATOR OR AUXILIARY PROTECTIVE ALARM SPARK GAP FOR HIGH FREQUENCY APPARATUS.

APPLICATION FILED JULY 27, 1904.

Fig. 1.

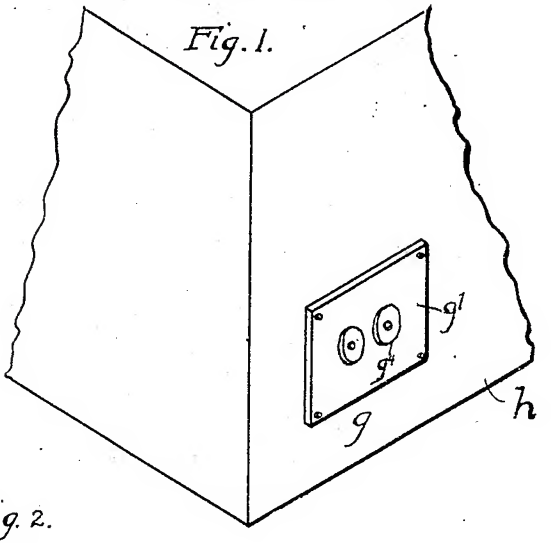


Fig. 2.

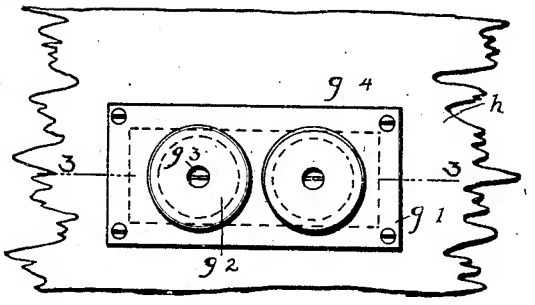


Fig. 3.

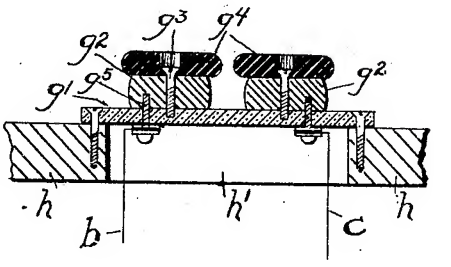
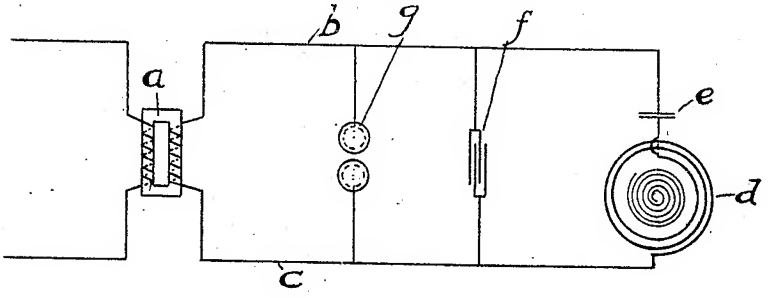


Fig. 4.



WITNESSES
Wm. L. Favrao.
J. B. Jackson.

INVENTOR.
Howard Jackson
BY Geo. H. Maxwell
ATTY.

No. 785,671. Patented March 21, 1905.

UNITED STATES PATENT OFFICE.

HOWARD JACKSON, OF NEWTON, MASSACHUSETTS.

DETONATOR OR AUXILIARY PROTECTIVE ALARM SPARK-GAP FOR HIGH-FREQUENCY APPARATUS.

SPECIFICATION forming part of Letters Patent No. 785,671, dated March 21, 1905.

Application filed July 27, 1904. Serial No. 218,438.

To all whom it may concern:

Be it known that I, HOWARD JACKSON, a citizen of the United States, and a resident of Newton, Massachusetts, have invented an Improvement in Detonators or Auxiliary Protective Alarm Spark-Gaps for High-Frequency Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The increased efficiency of high-frequency apparatus of the kind employed in connection with X-ray work, therapeutical work, and the like has occasioned the placing in the hands of novices and the unskilled of apparatuses more or less complex and requiring heavy and dangerous currents; and the present invention has for its object the provision of protecting mechanism for the apparatus in the form of means for automatically notifying the user of such apparatus in case anything goes wrong.

My invention includes in its preferred embodiment means for promptly notifying the user both by sound and sight and also by the sense of smell whenever an open circuit or other breakdown occurs.

The constructional details of my invention and the operation thereof and further resulting advantages will appear more fully in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In the drawings, Figure 1 is a fragmentary view of a cabinet, showing my invention applied thereto. Fig. 2 is an enlarged front elevation thereof. Fig. 3 is a cross-sectional view taken on the line 3 3, Fig. 2. Fig. 4 is a diagrammatical view showing the circuit connections

In many ways a breakdown is liable to occur in the use of the kind of apparatus in question—as, for example, if the spark-gap be improperly connected or accidentally omitted (as it often is for removal in cleaning or renewing) and the current is turned on the back discharge from the condenser will break down the insulation of the transformer—or the conductors from the condenser to the induction-coil or step-up transformer may become detached or imperfectly attached, in which case the whole output is thrown into the condenser and not having any other path to discharge excepting through the transformer immediately punctures the insulation thereof, as before. Accordingly I have provided an auxiliary device in the form of a spark-gap permanently in circuit and so situated as to be plainly visible at all times, being preferably on the outside of the box or case in which the apparatus is situated and also preferably containing means for giving off an offensive or pungent odor when heated, said auxiliary spark-gap being so adjusted as to be inoperative when the main circuit is working normally, but becoming operative instantly when the main circuit operates abnormally.

My invention is capable of a wide variety of embodiments, the form herein shown, however, being preferred because of its neat appearance, compact arrangement, and certainty and efficiency of action.

Referring to Fig. 4, I have indicated a transformer a, connected by wires b c to an induction-coil d, a Kinraide coil being shown for convenience, (see Patent No. 615,653, December 6, 1898,) operated in connection with a spark-gap e and a condenser f in the usual manner. I introduce across the circuit an auxiliary spark-gap or detonator g, being herein shown as between the transformer a and the condenser f, although it is obvious that it may be on the other side thereof or otherwise located, provided it is connected around the part or parts which are liable to cause the trouble. The constructional details of the preferred embodiment of this auxiliary spark-gap or detonator are shown best in Figs. 2 and 3, where it will be seen that the box or cabinet h is cut away at h' to provide a free and unrestricted opening to the interior, and over this opening h' I secure a heavy insulating-block g', of porcelain, glass, or other suitable non-inflammable material, on which are mounted opposite electrodes or discharge-buttons g^2, shown as retained by screws g^3, which also serve to retain protectors g^4 of hard rubber or other insulating and odoriferous material. Binding-posts g^5 connect the wires b c at their inner ends and engage the

electrodes g^2 as far apart as possible to prevent any danger of sparking across on the inside of the box. To make a distinctive and very loud noise and also to prevent any preliminary brush discharges, which might cause a sudden discharge, tending to annoy and interfere with the steadiness of the main apparatus, I make the electrodes g^2 g^2 circular in form, with rounded edges. This permits the electrodes to be brought almost as close together as the plates of the main spark-gap, without any tendency, however, to operate during the normal operation of the apparatus. The protectors g^1 are the same shape as the electrodes g^2 and overhang the latter, so as to prevent the operator from accidentally coming in contact with said electrodes, and yet leave the latter sufficiently exposed to permit the free circulation of air and to permit the arc to be visible whenever the detonator is called into action. The electrodes g^2 g^2 are adjusted apart sufficiently to provide a slightly greater resistance than that of the coil d and spark-gap e, which carry the oscillating current from the condenser, the adjustment of the device g determining the amount of strain that can be thrown upon the apparatus. This amount of strain will usually be greater or less, according to the character of the insulation of the transformer a. The latter is one of the most expensive portions of such an apparatus, and hence it is desirable to protect it in any event, and therefore the electrodes g^2 g^2 are usually adjusted from each other such a distance as to give prompt notice of any back discharge from the condenser or other similar danger liable to break down the insulation of the transformer.

In use if the apparatus is in proper condition, with all the parts properly adjusted and connected, the current passes in usual manner from the transformer a by the conductors b c to the condenser, whose discharges are passed through the coil d by the action of the spark-cap e. If now anything should occur to increase the resistance of the circuit or cause a breakdown therein, the current will immediately set the detonator g in operation, preferring this path of relatively low resistance to overcoming the impedance of the transformer, causing a loud and startling noise because of the discharge between the electrodes g^2 g^2, and as the device g is in plain sight the blinding light therefrom will also attract attention, and simultaneously therewith the smoking of the rubber protectors g^1 will compel attention by the sense of smell. Thereupon the operator instantly shuts off the current and is then at liberty to investigate at his leisure the cause of the trouble.

It will be evident that the apparatus may be guarded with any degree of nicety desired, according to the distance apart of the electrodes g^2 g^2. The auxiliary spark-gap or detonator remains idle or inactive at all times during the proper running of the apparatus to which it is applied, but is ever present and effective for warning the operator of any dangerous tendency of the condenser-current to flow back to the transformer. It does not depend in any way upon any special winding or contain any spring-actuated device or other movable parts; but it consists simply of a spark-gap not requiring any skill or understanding or attention on the part of the operator.

As already intimated, I am aware that many changes in form, arrangement, and combination of parts may be resorted to without departing from the spirit and scope of my invention.

Having fully described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An apparatus of the kind described, comprising an electric circuit, a cabinet, containing means for impressing thereon a high-frequency current, and a translating device, and means mounted on said cabinet in open view for giving instant visual warning upon the flow of destructive abnormal current, said means being protected from accidental contact.

2. A high-frequency cabinet for therapeutical work and the like, containing circuit-wires leading from a suitable source of current, a high-frequency high-potential disruptive discharge mechanism within said cabinet to operate in connection with said circuit, and an auxiliary detonator in parallel with said mechanism at the high-frequency high-potential end of said circuit, for giving instant audible warning upon the flow of destructive abnormal current.

3. A high-frequency cabinet for therapeutical work and the like, containing circuit-wires leading from a suitable source of current, a high-frequency high-potential disruptive-discharge mechanism within said cabinet to operate in connection with said circuit, and means responsive to the flow of destructive abnormal current for generating instantly a volume of bad-smelling gas or smoke capable of immediately permeating the atmosphere to the distance usually occupied by the operator, for giving warning to said operator by the sense of smell, said gas-generating means being mounted in an exposed position on said cabinet whence the said gas can freely escape in large volumes for the purpose set forth.

4. A high-frequency device for therapeutical work and the like, comprising a cabinet, containing a transformer, a condenser, a spark-gap device, and a translating device, and an electric circuit connecting said apparatus for producing a high-frequency high-potential disruptive discharge, and an auxiliary spark-gap device mounted on the outside of said cabinet and connected across said circuit between said transformer and said translating device, said auxiliary device being normally

inactive but capable of instant operation upon the flow of abnormal current for giving warning to the operator for preventing damage to the transformer.

5. A case containing electrical apparatus and having an aperture therethrough, a non-inflammable insulating-plate secured thereto, a spark-gap device mounted on said plate, and overhanging protecting means for said spark-gap.

6. A spark-gap device, comprising a support of non-inflammable insulating material, opposite electrodes mounted flat against the top surface thereof, and overhanging protectors mounted directly on said electrodes for preventing accidental contact therewith while leaving the spark-gap exposed and visible.

7. A spark-gap device, comprising a support of non-inflammable insulating material, opposite electrodes mounted thereon, and protectors mounted on said electrodes projecting over the discharge-gap, said protectors being composed of odoriferous material becoming active in the presence of the arc from said electrodes.

8. A spark-gap device, having separated electrodes provided adjacent their discharge ends with material capable of emitting an odoriferous smoke when heated by the discharge, for giving warning to the operator.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HOWARD JACKSON.

Witnesses:
GEO. H. MAXWELL,
EMILIO A. CARDARELLO.

T. B. KINRAIDE.

APPARATUS FOR FORMING A SMOOTH SURFACE ON METAL WHILE BEING MILLED.

APPLICATION FILED MAY 13, 1918.

1,336,239.

Patented Apr. 6, 1920.

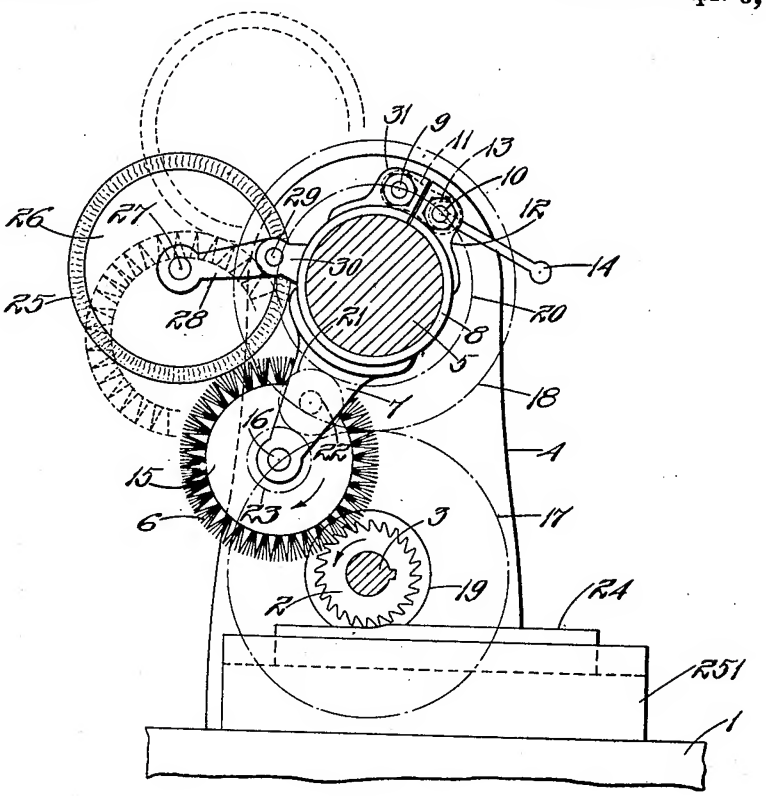


Fig. 1.

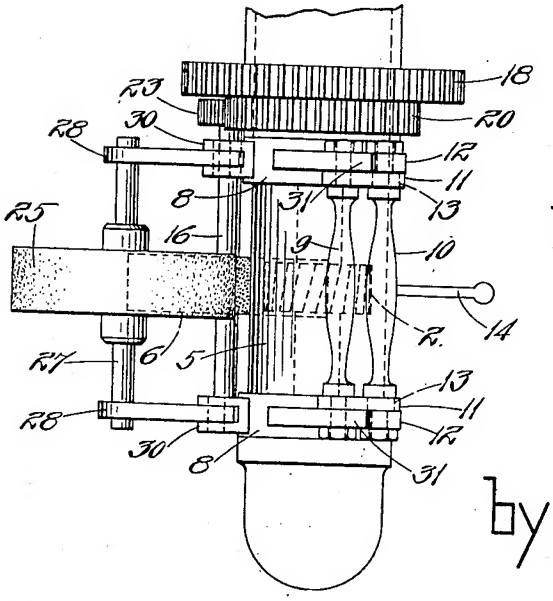


Fig. 2.

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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

APPARATUS FOR FORMING A SMOOTH SURFACE ON METAL WHILE BEING MILLED.

1,336,239. Specification of Letters Patent. **Patented Apr. 6, 1920.**

Application filed May 13, 1918. Serial No. 234,260.

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented a certain new and useful Improvement in Apparatus for Forming a Smooth Surface on Metal while being Milled, of which the following is a specification, reference being had therein to the accompanying drawings.

In the use of machines for milling down the surface of metallic bars or thinning down the bars to bring them to the requisite thickness, that is, surfacing them, as it is termed in the trade by the use of milling cutters, and of other cutters, it is well known that the chips formed by the cutter adhere to the cutting edges of the blades or teeth more or less, thus absolutely preventing a perfectly smooth surface being formed on the bar which is being worked, and in fact often times after a few turns of the cutter the chips accumulate so that by reason of their burring effect on the surface of the bar while the cutter is in operation, the surface of the bar becomes very much roughened. The softer the metal of the bar which is being worked, the rougher will be the surface after the cutter has been over it. This is noticeable to some extent in steel bars but it is especially noticeable in the softer metals such as aluminum, copper and lead. In copper and lead it is true to a very marked degree.

In many kinds of construction where metal bars are employed, it is extremely important, in fact absolutely necessary, that the surfaces shall be very smooth, for instance in the construction of crank cases for automobiles where it is important that the joints shall be very tight, the overlapping surfaces at their joints should be very smooth. It is also essential in aeroplane construction where aluminum is used to a considerable extent.

One object of the present invention is to provide a method of thinning down a metallic bar or plate and at the same operation forming a smooth surface on the face of the metal, said method consisting of surfacing the bar or plate by a cutter and clearing the cutting edge of the cutter automatically each time that the cutting edge passes out of contact with the metal plate before it again comes into operative contact with the plate.

Another object of the present invention is to provide an attachment for a milling machine which can be readily attached to the milling machines in ordinary use to automatically free the cutting edges of the blades of the milling cutter from the chips as fast as they are formed. Another object of the invention is to provide means for connecting the attachment with the milling machine in such manner that the cleaning device may be adjusted when desired, either in an operative position with relation to the milling cutter or out of operative position as desired.

The invention will be fully understood from the following description when taken in connection with the accompanying drawings and the novel features thereof will be pointed out and clearly defined in the claims at the close of this specification.

In the drawings, Figure 1 is a view in elevation, partly in section, of a portion of a milling machine, having attached thereto one form of a device embodying the invention.

Fig. 2 is a plan view of a portion of the top of the milling machine and the attachment embodying the invention.

Referring now to the drawings, 1 is a platen of a milling machine, partly broken away, the lower portion of the machine being omitted. A milling cutter 2 is mounted on an arbor 3 which is journaled in the column or arbor support 4. The arbor 3 is driven by any suitable mechanism. A horizontal arm 5 is mounted on the upper part of the arbor support 4, and mounted on said arm 5 is a yoke or hanger in which is journaled a rotary brush 6. In the form of device shown in the drawings, the hanger in which the brush 6 is journaled comprises two depending arms 7 parallel with each other which are respectively provided at their upper ends with straps 8 which encircle the arm 5, each of said straps being split transversely so that the strap may be spread open somewhat to permit its adjustment on the arm 5. Each strap has a boss 31 on the outer periphery near one end, which is connected with the boss on the cor-

responding end of the other strap by a tie rod 9, and the other ends of the two straps are connected together by a tie rod 10 which is journaled in the two bosses 12, 12 on the outer periphery of the two straps near the said other ends. The two tie rods are connected together by links 11, 11. An eccentric 13 is carried by the rod 10 at each end thereof. The rod 10 is provided with a lever arm 14 whereby said arm may be rotated. By rotating the said rod 10 the eccentrics 13, 13 are rotated in a manner to close or open the straps 8, 8 according to the direction of rotation of the eccentric, thereby causing the straps to grip or loosen their hold as the case may be on the arm 5. The straps are loosened for the purpose of permitting adjustment of the hanger on the arm 5 and are tightened again to clamp the hanger in its adjusted position. When the straps are loosened the hanger may be turned on the arm so as to swing the brush up out of contact with the cutter, as shown in dotted lines in Fig. 1, and the straps may then be tightened to hold the brush in the said inoperative position.

The brush 6 is preferably a bristle brush of cylindrical form, the tufts of the bristles being set into a cylindrical head 15 which is mounted fast on a shaft 16. The bristles are preferably short and stiff. Said shaft 16 is journaled in the depending arms 7 of the hanger.

By properly adjusting the hanger radially on the arm 5 the brush may be positioned so that the bristles will engage with the blades of the milling cutter 2 as shown in Fig. 1.

For the purpose of cleaning the blades of the cutter 2 the brush 6 should be rotated continuously when the cutter 2 is being rotated, and it is important that it should be driven in a direction so that the bristles of the brush will engage particularly with the cutting edges of the blades of the cutter, hence they should be rotated so that the travel of the blades and of the bristles of the brush will be in the same direction when they are in contact with each other, but at different speeds. It is preferable to have the brush travel faster than the cutter. Any suitable means of accomplishing this result may be employed. The means shown are as follows:

Mounted on the end of the spindle 19 which carries the cutter arbor 3 is a driving gear 17 which engages with a gear 18 mounted on the arm 5, the said two gears 17 and 18 being as one to one. Mounted fast on arm 5 is a gear 20 of smaller diameter than the gear 18. As shown in the drawings, gear 20 is formed integral with the gear 18. Said gear 20 engages with an idler 21 mounted on a stud 22 carried in one of the arms 7 and said idler engages with a gear 23 mounted on the brush shaft 16. The gears 20 and 23 are shown as proportioned three to one, so that the brush will make three revolutions while the cutter 2 makes one revolution. It will thus be seen that when the parts are adjusted as in Fig. 1, during the rotation of the milling cutter the brush will be constantly traveling at a greater rate of speed than the cutter and will be operative on the front or cutting edges of the blades of the cutter 2 and thoroughly clean the cutting edges of the blades from the chips of the metal which may be cut away from the surface of the bar which is being milled. The bristles being short and stiff and the cutter constantly turning its blades into the ends of these bristles, this causes a powerful thrust upon the particles of metal adhering to the blade so that the brush has two functions, it not only acts as a brush to wipe the particles from the blades, but it also acts as a matting tool upon the adhering particles and thrusts them away from the cutting edge. The drawing shows a bar 24 mounted on the feed block 251 in the process of being milled.

I have found that the chips or fine particles of metal which are cut from the bar which is being operated upon are less likely to adhere to the cutter, or if they do adhere to the cutter, they are more easily brushed away, if the blades of the cutter are kept oiled. Inasmuch as it is not desired to have a large amount of oil on the cutter at any time, but rather to keep the blades slightly oiled all of the time, I have found it productive of good results to keep the brush 6 oiled and to oil the blades by means of the brush 6 at the same time that the brush cleans the blades. In order to keep the brush 6 constantly oiled without dripping I provide an oiling roll which is of the same width as the brush and against which the brush will contact during its rotation.

This oiling roll is preferably a pad of felt 25 or other equivalent material mounted on the periphery of a wooden core 26. The said roll is mounted loosely on a shaft 27 so as to be rotatable thereon. Said shaft 27 is mounted fast in the arms 28 which are pivotally connected at 29 with arms 30 which project from the outer periphery of the straps 8 of the hanger which carries the brush. By reason of the pivot connection of the arms 28 with the straps 8 the oiler roll 25 will when the device is mounted as shown in Fig. 1, drop by gravity into contact with the brush roll 6.

The pad 25 is sufficiently saturated with oil so that as the brush in its rotation engages the periphery of the oil pad the bristles of the brush will be constantly re-oiled.

The oil roll need not have any independent means for rotating the same but it will be

caused to rotate by its frictional contact with the brush so that all portions of the periphery of the oil roll will successively be brought into operative contact with the brush.

While I have described one form of attachment for a milling machine whereby the blades of the cutter are cleaned automatically during the rotation of the cutter, I do not intend to limit the claims to the particular form of mechanism shown, said mechanism being illustrative of one form of means for cleaning the blades. My invention resides broadly in the idea of automatically cleaning the cutting edges of the blades during the movement of the cutter after each operative contact of a blade before it again comes into operative engagement with the metal which is being milled, or in other words, it resides broadly in the method of cutting down the surface of a metal plate in such manner as to constantly leave a smooth surface where it is milled down, said method consisting of removing the metal from the surface by a cutter and cleaning the cutting edge of each blade automatically each time after it leaves the metal before it again comes into contact with the metal.

What I claim is:

1. In combination with a milling machine having a rotary cutter, a rotary bristle brush whose axis extends parallel with the axis of the cutter, a yoke in which said brush is journaled, a supporting shaft parallel with the axis of said brush, means for adjustably securing said yoke to said shaft to maintain the brush parallel with the axis of the cutter, the yoke being adjustable to change the position of the brush toward and away from the cutter, and means for maintaining the yoke in its adjusted position, so that the brush may be maintained either in engagement with the cutter or entirely free from the cutter, as desired.

2. In combination with a milling machine having a rotary cutter, a rotary brush whose axis is parallel with the axis of the cutter, a mount in which said brush is journaled, so located that the brush engages with the cutter during the rotation, and a rotary oiling roll which engages with the periphery of the brush throughout the length of the brush, and bears with a pressure on said brush.

3. In combination with a milling machine having a rotary milling cutter, a rotary brush whose axis extends parallel with the axis of the cutter, and means for supporting said brush in relation to the said cutter, said supporting means comprising a shaft which extends parallel with the axis of the brush and of the cutter, a strap adjustably secured to said shaft, an arm projecting from said strap and having bearings in which said brush is journaled, said strap being adjustable on said shaft whereby the bearing for the brush is radially adjustable to vary the position of the brush with relation to the cutter.

4. In combination with a milling machine having a rotary milling cutter, a rotary brush whose axis extends parallel with the axis of the cutter, and means for supporting said brush in relation to the said cutter, said supporting means comprising a shaft which extends parallel with the axis of the brush and of the cutter, a strap adjustably secured to said shaft, an arm projecting from said strap and having bearings in which said brush is journaled, said strap being adjustable on said shaft whereby the bearing for the brush is radially adjustable to vary the position of the brush with relation to the cutter, an oiling roll and an arm projecting from said strap with which said oiling roll is pivotally connected in such manner that the oiling roll bears upon the periphery of said brush.

5. In combination with a milling machine having a rotary milling cutter, a rotary brush located in position to engage the blades of the cutter during the rotation, and an adjustable mount for the brush, said mount being adjustable to bring the brush into position to engage the blades of the cutter and to shift the brush out of engaging position, and means for maintaining the mount with the brush in the adjusted position, either in engagement with the cutter or entirely free from engaging position with the cutter, as desired.

6. In combination with a machine having a rotary milling cutter, a rotary brush, means for holding the brush so that it may at will be located in position to engage the blades of the cutter during the rotation or in a position where it will be out of engagement with the cutter, and means for maintaining the brush in the adjusted position, either in engaging position with the cutter or entirely out of engaging position as desired.

7. In combination with a milling machine having a rotary milling cutter, a brush which extends alongside of the cutter its full length, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotating both the brush and the cutter, and a rotary oiling member which engages with the brush throughout the entire length of the brush and thereby applies oil to the brush as the brush and oiling member rotate in engagement with each other.

8. In combination with a milling machine having a rotary milling cutter, a rotary bristle brush, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotat-

ing the cutter and the brush, and means for automatically applying oil to the said brush during the rotation.

9. In combination with a milling machine having a rotary cutter, a rotary bristle brush, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotating the cutter and the brush, a second rotary member located in position to engage said bristle brush, said second rotary member being provided with an oil pad on its periphery whereby it maintains the ends of the bristles of said first brush in an oily state.

In testimony whereof I affix my signature.

THOMAS B. KINRAIDE.

N° 15,246 A.D. 1898

Date of Application, 12th July, 1898—Accepted, 10th Sept., 1898

COMPLETE SPECIFICATION.

Improvements in Automatic Break or Interrupter Apparatus for Electric Currents.

I, THOMAS BURTON KINRAIDE, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

It is the object of my invention to provide an improved automatic break or interrupter for electric currents, my invention being particularly adapted for use in interrupting the primary current of induction coils in connection with X-ray and kindred apparatus.

My invention secures high speed and accuracy of break, the successive breaks being rendered similar and synchronous, provides uniformity of wear of the make-and-break contacts, cures the irregularity and unsteadiness of the current hitherto so objectionable, increases the frequency, and gives uniform action of both current and apparatus under different resistances, besides simplifying and prolonging the life of the instrument.

As heretofore constructed, these instruments have had a break hammer carried on the free end of an ordinary leaf-spring vibrating between the core-end of an electro-magnet and a small contact or anvil, the latter being mounted on the end of an adjusting screw in the free end of a post or standard.

One serious drawback to these instruments has been that the speed of interruption, *i.e.*, the speed of the vibrations of the hammer, has been quite limited and there has been an unevenness of break.

I have found that these faults are due to a compound vibration of the instrument which tends to hasten some of the breaks and to retard others, and I have further found that this compound vibration, as I call it, may be obviated and that high speed may be attained and accurate breaks secured by providing an absolutely rigid and unyielding post or standard; as a result of this feature of my invention, the objectionable inaccuracy and unevenness of the breaks or interruptions dissappear, and a nicety of adjustment and compensation is feasible which would not otherwise be possible.

A further objection to the present old style of instrument, above mentioned, is that as the tension of the spring vibrator is increased to vary the electrical resistance of the break, the sparking of the instrument is increased, the current being also otherwise rendered irregular and uncertain, and I have discovered that this is due to the fact that in the adjustment of the vibrator the hammer is thrown more or less out of alignment with the core-end and anvil.

It is therefore one chief feature of my invention to provide means to maintain the hammer in proper accurate alignment with its core and anvil.

Again, irregularity and unsteadiness of current are due to the uneven wear of the contacting surfaces of the hammer and anvil, the intense heat of the constant arcing serving to fuse and batter down the said surfaces unevenly; and therefore I have

[*Price 8d.*]

mounted one of these surfaces on a rotatable spindle, so that the irregularities thereof may be automatically removed or obviated by rotating it as the hammer is vibrated.

In order still further to increase the efficiency of the break, I make the several parts thereof laminated, so as to get rid of the heating effects, thereby permitting the break to be extremely rapid.

In this connection also I provide a collector for the lines of force, thereby enabling a smaller hammer to be used with the effect of a large one.

Other advantages and features of improvement will be pointed out in the course of the following description of the details of construction.

In the drawings I have omitted all unnecessary details, confining the drawings to the details of improvement, and it will be understood that the latter may be used in connection with any suitable or preferred general style of apparatus.

Fig. 1 is an end elevation, partly broken away, showing one embodiment of my invention.

Fig. 2 is a top plan view thereof.

Fig. 3 is a broken detail in side elevation, showing a slight modification.

Fig. 4 is a side elevation of the collector, a portion of the hammer being shown in operative position.

Fig. 5 shows a detail of a modified collector.

Fig. 6 is a fragmentary detail in top plan, showing a rigid collector placed on the side of the hammer opposite the coil.

Fig. 7 illustrates one of the objectionable features of the old style instrument.

On a suitable base A is mounted a coil B supported by end supports c, c^1, herein shown as receiving the core b at its ends.

The hammer D, carried by a vibrator E, reciprocates between the core end b^1 and an anvil G, the hammer having a reduced end e held rigidly on the vibrator by a nut e^1.

Heretofore this vibrator has been a leaf-spring h, as indicated in Fig. 7, this spring being deflected more or less to the right when it has been desired to increase the electrical resistance offered by the hammer, the result being as shown in exaggerated form in Fig. 7, where it appears that the spring h when deflected to its dotted position inevitably upsets the hammer, so that the latter, when attracted to the core b^1, strikes the latter with its upper edge d^2 only, thereby increasing the resistance entirely out of proportion to that intended, and tending to burn or fuse the small point of contact d^2, also leaving a spark gap d^3, tending to ruin the hammer; the disastrous effects at the opposite end of the hammer being of the same sort excepting that the contact surfaces being smaller and composed of platinum, said effects are still more serious.

Accordingly, I obviate these disastrous results by making the vibrator E rigid and unyielding for most of its length, as shown at e^2, a short resilient section e^3 being preferably provided at its lower end next to the stud a, to which it is shown as fastened, and the necessary tension being secured by means of an auxiliary or tension spring K on the shank of an adjusting screw k, working at its threaded end in a post a^1 and journaled at k^1 in a standard a^2.

An adjustable thumb nut k^2 receives one end of the spring K, the opposite end bearing against the vibrator E which rides loosely over the screw rod k.

In this preferred form of mechanism for accomplishing my object, turning the screw k to the right or left correspondingly relaxes or tightens the spring K, thereby tending to move the vibrator E bodily forward to a greater or less extent to increase the number of amperes or quantity of current transmitted, and it will be noted that the hammer does not depend on the vibrator for its tension or resistance, but rather on the independent spring K, which bears centrally forward against the vibrator, the yielding section e^3 flexing readily, enough to permit the required movement forward of the rigid portion e^2.

I prefer to place the hammer at one side of the core, directly in the field of the greatest number of lines of force, the direction of the latter being indicated by

arrows in Fig. 2, whereby the action of the apparatus is very materially improved; and in order still further to increase the frequency, and to get rid of the heating thereof, so that the brake can be extremely rapid, I make the several parts thereof laminated, as clearly shown, the core being preferably composed of a plurality of wires, and the hammer of a number of plates secured together, although any other means of lamination is within my invention.

In connection with the improved hammer, I provide means for positively limiting its movement, said means being herein shown as a projection or engaging lug e^4 on the vibrator cooperating with a stop e^5 preferably adjustable.

By reason of this construction the length of the spark gap between the hammer D and its anvil G is positively controlled, so that the time period of the interruptions may be regulated to the requirements of the circuit, for discharging the condenser at the proper moment to accelerate the inductive action of the primary of the induction coil with which we will suppose the apparatus is being used.

Adjacent the hammer and preferably above it I provide a collector L for the lines of force, to direct them upon the hammer, whereby a much smaller hammer may be used than would otherwise be possible for the same effect.

In Figs. 1, 2 and 4, this collector is shown as composed of a body of metal L, preferably soft steel or iron and laminated, placed within the field of force of the coil and immediately adjacent the hammer, thereby presenting to the hammer a field of strong magnetic intensity, so that it is equivalent to making the hammer much larger, at the same time permitting a much smaller moving part than usual.

Preferably this collector is movable relatively to the hammer, so that its effect on the latter may be varied, as indicated in Figs. 1—5, where the collector is shown as pivotted at l and as having its lower end convexly curved (Fig. 5) adjacent the hammer D, or internally formed to endorse said hammer (Figs. 1, 4).

By means of the collector the amount of current delivered through the break is readily controlled, inasmuch as the collector tends to gather in the lines of force and direct them to the hammer; so that if the collector is in the full line position, Figs. 1 and 5, the greatest intensity will result, whereas if the collector is in its dotted line position, a less intensity will result, and this may be varied according to the position into which the collector is swung, the resultant effect upon the hammer being that it has an active or sluggish movement according to the position of the collector.

When the collector is swung entirely away from the hammer or in case it is omitted entirely, the tendency of the hammer is to lag or hang to the anvil as it is drawn away, whereas with the collector in its full line position, as shown, the action of the break is short and quick.

The collector is shown as laminated, Fig. 5, showing it applied to a break having its hammer at the end of the core, while the other figs. show the collector applied to the special form of hammer forming part of my new break.

The configuration and position of the collector may be changed to include a greater or fewer number of the lines of force, or into the entire field, according to the effect it is desired to produce upon the hammer, one example being illustrated in Fig. 6 in which the collector L^1 is shown as mounted at the side of the hammer opposite the coil.

With this construction, whenever, by the tearing off of small pieces of the metal from the contact points, the break gap is partially short circuited when open, the rapidly increasing lines of force are so concentrated by the collector upon the hammer as to drag the latter sideways, toward the collector, thus overcoming the short circuit by shearing apart the fused particles and separating the points, the hammer then resuming its normal vibration.

It will be understood that as the hammer end e is pulled away from the anvil G, an arc is formed which inevitably fuses a slight portion of the opposing surfaces, and, as the breaks are rapid these surfaces, although platinum, are quickly rendered uneven.

Accordingly, I provide means to relatively rotate the meeting surfaces of the anvil and hammer, independently of the rotations due to the adjustments of said parts, the said means being herein shown as preferably consisting of a freely rotatable spindle g centrally mounted in a hollow adjusting screw g^1 having threaded engagement with an extended bearing a^3 in the standard a^4, being fixed in its adjustments by a check nut g^2.

The spindle g is rotated by a thumb wheel g^3 pinned on its outer end, and is held against longitudinal movement by a collar g^4 fixed near its inner end to abut against the inner end of the screw carrier g^1.

The spindle is threaded at g^5 to receive the anvil G the latter being shown in the form of a threaded cap provided with a required platinum contact, the platinum being soldered thereon, as indicated in heavy section lines Fig. 1.

The collar g^4 and anvil are made of a size to permit them to be withdrawn together, with the adjusting screw g^1, as the latter is screwed out of the standard a^4.

It is understood that as the platinum points wear and fuse away the anvil is nicely adjusted forward by its screw carrier g^1 to compensate therefor.

Under the old construction the surfaces would fuse and wear unevenly, as explained, and then when it became necessary to adjust the anvil forward, it would be impossible because it would be found that the surfaces had become more or less interlocked, thereby preventing any relative rotation thereof, the result being that the apparatus was rendered useless until the anvil had been removed and the contacting surfaces carefully filed down, not only entailing loss of time but loss of the platinum.

According to my invention the adjusting movement is entirely independent of any rotation of the anvil.

In order to give the most efficient work, the breaks should not only be exceedingly rapid, but they should be even or accurate in synchronism.

Accordingly, I have rendered the standard, which supports the anvil, absolutely rigid and non-vibrant, finding as a result that the accuracy of break which is sought is thereby attained, and that the speed or note of vibration is raised, this being due to the prevention of compound vibrations.

I prefer to render the standard thus rigid by interposing a bar or brace M, Figs. 1 and 2, or M^1, Fig. 3, of insulating material between opposite posts of the frame, this bar being let into the frame and held rigid by said screws, the object being to prevent the standard, and hence the anvil, from being responsive to the vibrations of the hammer, and thereby occasioning a compound or confused vibration or interruption of the current.

Various modifications and details of mechanisms may be used to embody my invention.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

In an automatic break or interrupter for electric currents:—

1. A high speed break, comprising a coil and its core, an anvil in electric circuit with said coil, a standard supporting the anvil, and means to render said standard absolutely non-vibrant, whereby compound vibrations are prevented and the speed is increased, substantially as described.

2. A high speed break, having a hammer vibrating between a core-end and an anvil, means to vary the vibrating resistance of said hammer, and means to maintain said hammer in approximately unvarying end alignment with said core-end and anvil, substantially as described.

3. A high speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer, substantially as described.

4. A high speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer and being provided at its

opposite end with means to permit said rigid portion to be deflected slightly, substantially as described.

5. An electric break, having a hammer vibrating against an anvil, and means to adjust the latter, means to rotate said anvil independently of its said adjustment, snbstantially as described.

6. An electric break, the combination with a hammer, its anvil, and a hollow adjusting screw for the latter, of a spindle carrying said anvil and rotatably mounted therein, substantially as described.

7. The herein described anvil, the same consisting of an interiorly threaded cap, and a centrally extended platinum contact integrally secured thereon, substantially as described.

8. The combination with an electric break having an electro magnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, substantially as described.

9. The combination with an electric break having an electro-magnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, and means to vary the position of said collector relatively to said hammer, substantially as described.

10. The combination with an electric break, having an electro magnet, an anvil, and a vibrating hammer, of means to shear or drag sideways the hammer from the anvil whenever the break-gap between the hammer and anvil is partially short circuited by the fusing or clinging of the metal at the contact points, substantially as described.

11. An electric break of the vibrator class, provided with a hammer composed of laminated material, substantially as described.

12. An electric break, a core, a hammer, and collector, to concentrate the lines of magnetic influence on the hammer, said collector being composed of laminated material, substantially as described.

13. The combination with an electric break, having an anvil and a vibrating hammer, of a positive stop to limit and positively stop the movement of the latter from the anvil, substantially as described.

Dated the 9th day of July 1898.

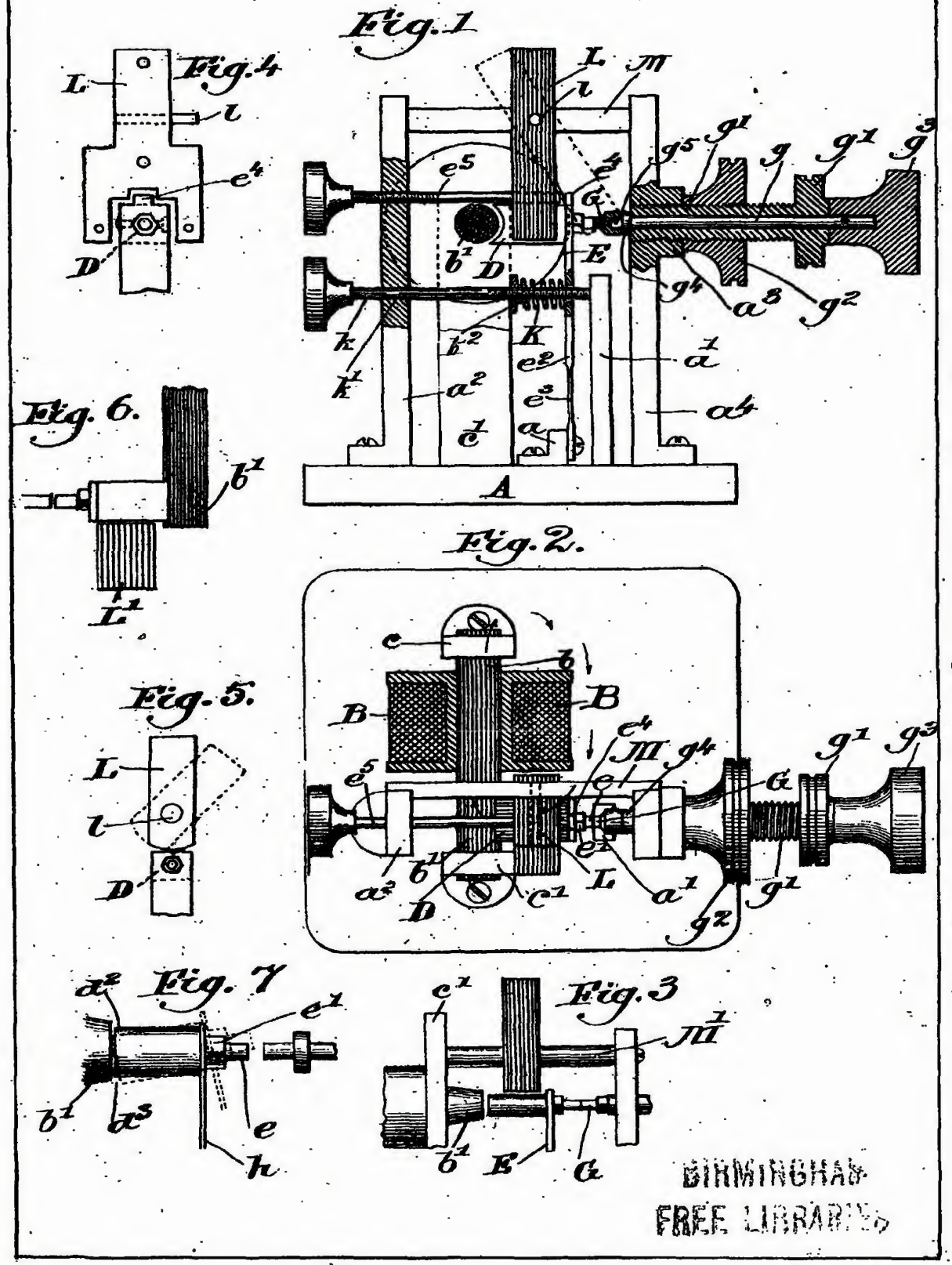
WM. BROOKES & SON,
55 & 56. Chancery Lane, London,
Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1898.

A.D. 1898. JULY 12. N° 15,246.

KINRAIDE'S COMPLETE SPECIFICATION.

(1 SHEET)



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

N° 5518 A.D. 1899

Date of Application, 14th Mar., 1899—Accepted, 8th July, 1899

COMPLETE SPECIFICATION.

Improvements in Electric Spark Gap Apparatus.

I, THOMAS BURTON KINRAIDE, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The more recent developments in electrical matters, and particularly in the line of experimental research in connection with static electricity, has developed conditions requiring the discharge of such enormous potentials and amperage as to render the apparatus heretofore provided for such purposes inefficient and largely useless, for the reason that these enormous discharges which the electrician frequently desires to experiment or deal with very quickly render inoperative or destroy such usual apparatus.

Accordingly, it is the object of my present invention to provide a practically indestructible discharge apparatus to meet the more exacting requirements of the present day, and to that end I provide a spark gap which is virtually self-recuperative, and comprises opposite parallel discharge surfaces of considerable area, which, besides their practically indestructible character, possess numerous very important advantages all as will be more fully pointed out in the course of the following detailed description of the apparatus, reference being had to the accompanying drawings illustrative of preferred embodiments thereof.

In the drawings, Fig. 1 represents in side elevation a simple form of my improved spark gap.

Fig. 2 is a similar view shewing a modification.

Fig. 3 is a top plan view of the form of apparatus shewn in Fig. 2.

I provide electrodes preferably in the form of opposite parallel discs g, g^1, the air gap between whose frame surfaces constitutes the spark gap, the extended area of these electrodes preventing the tendency of the condenser (for example) with which my invention will ordinarily be used, to discharge until it has reached its maximum charge, and also causing the discharge to be exceedingly sudden when it does take place, and the discs not being liable to become unduly heated.

The spark gap constitutes virtually a self-recuperative condenser, as it were, the parallel, and preferably plane, metallic surfaces g, g^1, being the discharge surfaces which discharge through or across the intervening air dielectric. The air gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the discs are, the greater condenser capacity will they have, and hence the further apart they will spark.

At each discharge of the condenser a small portion of the plates g, g^1, is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two discs are completely oxidised. These discs may be made of copper or other suitable conductor material.

Suitable means is provided for accurately adjusting these plates relatively to each other and regulating their distance apart, or, in other words, for controlling the resistance of the intervening gaseous dielectric, and referring to the drawings, where

I have shewn a preferred means for accomplishing my object, it will be seen that I provide a plurality of posts g^2 threaded at their upper ends and carrying shouldered nuts g^3 on the shoulders of which is placed the top disc g^1.

The opposite plate g rests on a support or table g^4 and is mounted loosely on a post g^5, being normally held downwardly by a spring g^6 contained in a hanger or housing g^7 depending from the table g^4 said spring bearing at one end against the flanged lower end of the hanger g^7 and at its other end bearing against a washer g^8 retained by a screw g^9 whose head enters a hole or recess in the plate g for centering the latter.

The plate g is provided on its underside with a plurality of recesses or sockets, herein shewn as three in number, which receive props or struts g^{10} projecting upwardly from the base of the instrument.

These props g^{10} are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g^1.

The support g^4 has depending from its lower side a stud g^{11} which is engaged by the bifurcated end g^{12} of a lever g^{13} pivoted at g^{14} to a post g^{15} on its base.

By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other so as to incline the struts g^{10} more or less, and thereby increase or decrease the distance between the plates g, g^1, the nuts g^3 being depended upon for the coarser adjustments of the plates.

In Figs. 2 and 3 I have shewn the plates g, g^1, as hollow and provided with water circulation pipes g^{16}, in order that they may be absolutely prevented from all heating under extraordinary conditions.

Under usual conditions, however, this provision is entirely unnecessary, it being sufficient simply to provide the plates as shewn in Fig. 1.

When the adjacent surfaces of the plates have become entirely oxidized, the plates may be turned over and their opposite sides used, and when both sides have become oxidized, they may be readily removed and scoured off without destroying any of their adjustments.

My apparatus makes possible the sudden discharge of a condenser after the latter has reached a certain predetermined point, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations incapable of being obtained between a ball or point discharge gap.

The adjustment of the plates relatively to each other regulates the amperage discharge of the instrument being discharged.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A spark gap of the kind described, said spark gap presenting opposite parallel discharge surfaces of relatively large areas, and means for regulating the discharge distance between said parallel surfaces, substantially as described.

2. The herein described spark gap comprising opposite electrodes presenting parallel discharge surfaces, one of said electrodes being supported on three or more struts of equal length, and means for rotating said strut-supported electrode about its centre, whereby its adjustment may be varied to and from the opposite electrode, substantially as described.

3. A spark gap comprising two permanent large superficial areas parallel to each other, constituting opposite discharge surfaces, and an interposed gaseous dielectric, said discharge surfaces having condenser capacity for breaking down the intervening dielectric, and the latter automatically restoring or renewing itself, substantially as described.

4. A spark gap comprising opposite hollow plates or discs having parallel discharge surfaces, means for regulating the discharge distance between said surfaces, and

circulation pipes entering the same, whereby a circulation of water may be maintained for keeping the plates or discs cool, substantially as described.

5. A spark gap comprising three or more posts, shoulders adjustable thereon, a plate or disc supported on said shoulders, a second plate below the same, a support therefor, three or more upright struts loosely engaging said support, and means to rotate said support about its centre, whereby said struts are simultaneously and similarly moved for varying the distance apart of said plates, substantially as described.

6. A spark gap comprising a central post, a plurality of supporting posts, two plates, one carried by said supporting posts and the other adjacent said central post, three or more similar struts supporting said lower plate, a spring maintaining said struts in proper supporting relation, and means to rotate the lower plate on said central post, substantially as described.

7. A spark gap comprising a plurality of supporting posts, two plates, the lower plate being pivotally mounted, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

8. A spark gap comprising a central post, a plurality of supporting posts, two plates, the lower plate being pivotally mounted concentrically to said central post, a hanger depending adjacent said post, a spring between said post and hanger and engaging the hanging at its lower end and held by the post at its upper end, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

Dated the 14th day of March 1899.

WM. BROOKES & SON,
55 and 56, Chancery Lane, London, Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899.

A.D. 1899. March 14. N° 5518.

KINRAIDE'S Complete Specification. *(1 SHEET)*

Fig. 1.

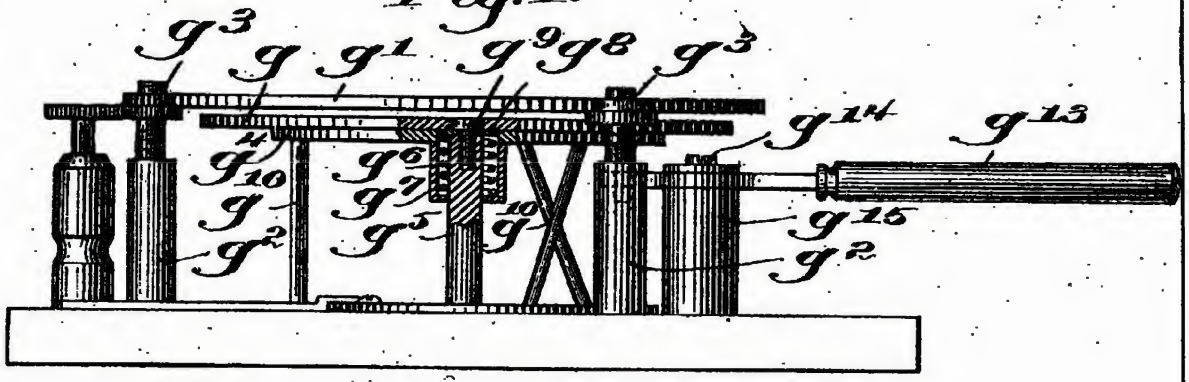


Fig. 3.

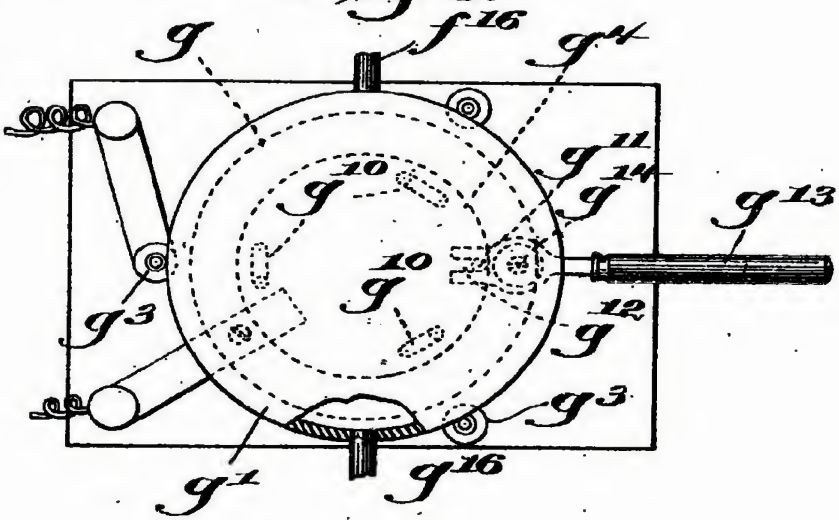


Fig. 2.

[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

N° 5519 A.D. 1899

Date of Application, 14th Mar., 1899--Accepted, 15th Apr., 1899

COMPLETE SPECIFICATION.

Improvements in Electric Break Apparatus.

I, THOMAS BURTON KINRAIDE, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Electric breaks as heretofore provided have been subject to considerable sparking, which is not only destructive of the apparatus but is very objectionable in its effects on the current and system being operated, this being especially true of rotary breaks which operated by means of a brush in frictional engagement with a rotating surface.

Accordingly I have invented a break in which there is no chance for arcing as there is no surface to arc over, and also a leading object of my break is to provide a means for making an exceedingly quick break with a relatively long period of closed circuit, my break rendering it possible to regulate the period of closed circuit accurately.

In the drawings Fig. 1 is a top plan view of one form of my break.

Fig. 2 shows the same in elevation.

On a suitable base D I journal in a central post or bearing d a spindle d^1 of an iron plate or armature d^2, having two or more regions of varying mass of magnetic material, herein shown in the form of eccentric edges d^3, as clearly shown in Fig. 1.

My object is to provide regions of increasing magnetic attraction to cooperate with one or more suitable electro magnets or solenoid devices, so located as to successively attract these regions of varying mass of magnetic material, for rotating the armature, as will now be explained.

Mounted on or otherwise connected to rotate with the armature d^2 are one or more small antifriction rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5 clamped adjustably on the plate d^2.

These rolls or circuit interrupters are preferably of indurated fibre.

Mounted to extend into the path of the rolls d^4 is an arm shown as a wire d^6 carrying a hammer d^7 to contact with an anvil d^8 on a post d^9, and limited in its movement by a fibre stop d^{10} on the end of an adjusting screw d^{11}.

The wire d^6 is carried by a hub d^{12} loose on a pin d^{13} and held under tension by a spring coil d^{14}, Fig. 2, fastened at one end to said hub and at its other end to a nut d^{15} carrying an adjusting or set screw d^{16}; so that by loosening the set screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied.

Preferably adjacent the periphery of the armature d^2, I place attracting means,

[*Price* 8*d*.]

herein shown in the form of solenoids or electro magnets d^{17}, d^{18}, connected with the main or other source of current by wires d^{19}, which enter the solenoids at their inner terminals, so that as the magnets d^{17}, d^{18} are energised, they attract the armature or plate d^2, and by the increasing pull exerted thereon, on account of the eccentric surfaces d^3, they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^5, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break.

Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post *d*, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other.

The same effect may be obtained by shifting the roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted.

This adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus I provide the swinging carrier d^{20}.

A movement of the carrier from right to left causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved further toward the left, the pull on the armature exerted by the magnets is diminished more and more, and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks, and at the same time lengthening the time which the circuit being interrupted is closed.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 1, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end.

The arm d^6 is connected to the main or branch therefrom, at d^{21} by means of any suitable conductor d^{22}, and the anvil d^8 has a connection d^{23} to the delivery end d^{24} of the circuit as will readily be understood.

In operation the magnets being energised attract the eccentric surfaces or other varying masses of magnetic material so as to cause the armature to rotate over to the left, Fig. 1, the circuit being completed at d^7, d^8, until the very moment when the interrupter d^4 strikes the free end of the arm d^6, whereupon the circuit is instantaneously broken and as this time occurs slightly before the highest points, or places of greatest attraction of the armature, come opposite the solenoids, the latter are rendered inactive merely during the moment when the momentum of the armature is carrying the latter by the solenoids so as to bring the region of least magnetic mass again opposite the solenoids in position for the latter, upon becoming active by the making again of the circuit, to renew their pull upon the armature and thereby continue its rapid revolution.

This action is rapidly repeated at every make and break of the instrument.

I prefer to provide opposite solenoids in order to render the device perfectly balanced and smooth running, although it will be understood that variations in this and in all other details of my invention may be made.

By the use of my invention the time period of closed circuit may be made as considerable as desired.

With any usual break this would be impossible for the reason that in order to give an equivalent period of closed circuit the brush would of necessity remain upon the surface of the break so long as to heat frictionally the surfaces so as to produce a constant arc, ultimately destroying the break as well as the efficiency of the circuit.

In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electric break comprising a rotating member, an electro magnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, substantially as described.

2. An electric break comprising a rotating member, an electro magnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

3. An electric break comprising a rotating member, an electro magnet, a spring, a break device, means to vary the resistance of said break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

4. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter driven by said rotating member for interrupting the break device, substantially as described.

5. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, substantially as described.

6. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, substantially as described.

7. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a pivotted roll carried by said rotating member for interrupting the break device, and means for adjusting said roll on said rotating member, substantially as described.

8. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a bar fixed on said rotating member and provided with rolls pivotted thereon at its opposite ends in line with and to interrupt said break device, substantially as described.

9. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, said break device being mounted on a carrier movable concentrically to said rotating member, substantially as described.

10. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a revolving interrupter driven by said rotating member, said break device including a yielding arm projecting obliquely into the path of said interrupter, substantially as described.

11. An electric break comprising an arm carrying a hammer, an anvil opposite said hammer, said arm being yieldingly supported and provided with means for

regulating the tension or resistance thereof, an interrupter for engaging the free end of said arm, and automatic means operated by the current being broken for driving said interrupter, substantially as described.

Dated the 14th day of March 1899.

WM. BROOKES & SON,
55 & 56, Chancery Lane, London, Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899

A.D. 1899. March 14. N° 5519.

KINRAIDE'S Complete Specification.

(1 SHEET)

Fig. 1.

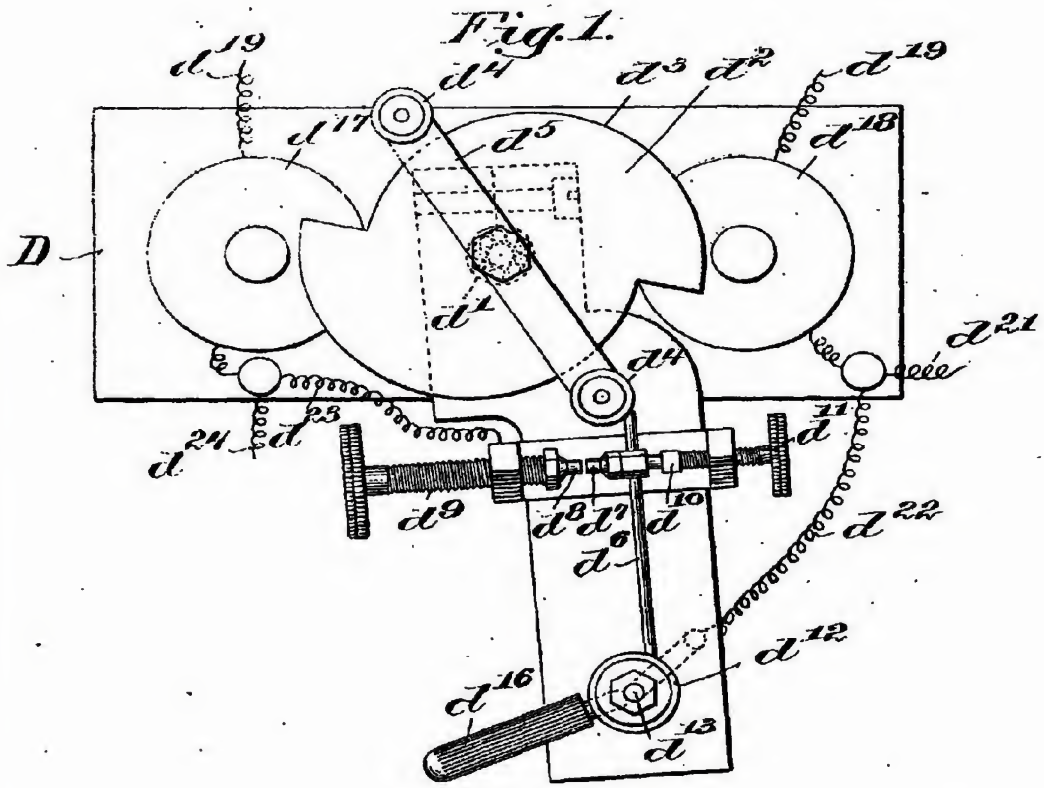
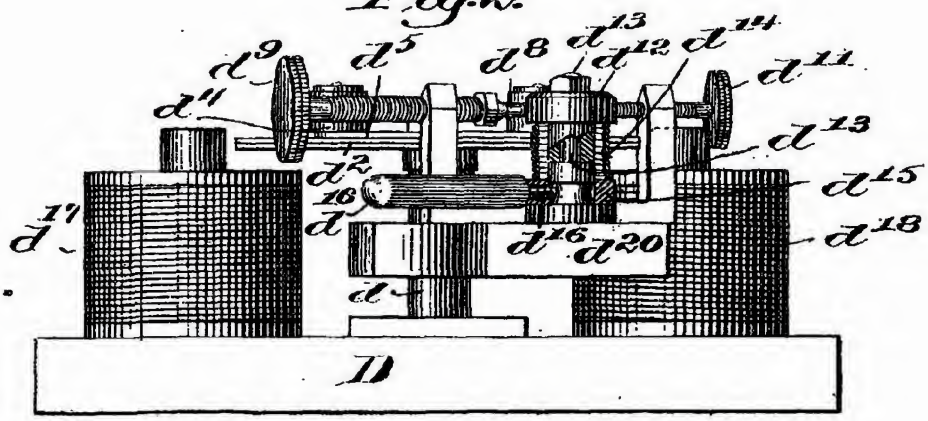


Fig. 2.



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Malby & Sons, Photo-Litho.

N° 12,408 A.D. 1901

Date of Application, 18th June, 1901—Accepted, 20th July, 1901

COMPLETE SPECIFICATION.

Improvements in and relating to Static Rectifiers and other Electrical Apparatus for Producing or Maintaining Continuous or Unidirectional Discharges

I THOMAS BURTON KINRAIDE, of 38 Spring Park Avenue, Boston, State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is shown as embodied in an electrical machine of the kind known as static rectifiers, but the invention considered in its broader features is not restricted to this particular electrical machine, but is of wide application to various kinds of electrical apparatus, and embodies certain important discoveries which I have made, whereby I am enabled to positively maintain an electrical discharge in one direction only, and under proper conditions to maintain said discharge continuously, producing, for instance, without the intervention of a commutator, a continuous current, directly from an alternating or intermittent current.

Without necessarily stating that such is the fact, it may be supposed that there is simply electrical energy and that the presence of said energy is what we call a positive condition, and the absence of said energy is what we call a negative condition, and this, taken with my discovery that electric energy in its positive condition discharges reluctantly from a plane (without edges, or angular or pointed surfaces) and discharges with perfect freedom from a point, enables me to control the direction of discharge of the current and hence the accumulation of potential.

The requisite conditions are provided by means of what I term an extensionless point which provides, as nearly as it can be done mechanically, the ideal discharge electrode or positive condition for the outward flow of the electrical energy, and by means of what I term a limitless plane which provides in the same manner the receptive electrode or negative condition in which there may be said to be an absence of energy (or a lower potential than that of the point from which the discharge comes), analogous to a vacuous condition or absence of electrical pressure.

By this means, the electrical energy tends to discharge continuously in one direction only, *viz* : from the extensionless point to the limitless plane.

I have applied my invention in various ways, as, for instance, in a static machine in which the receiving electrode has an extended plane surface or large flat area of the limitless plane type and the discharge electrode has a point discharge or preferably a series of points like a usual cone; but for the purposes of fuller explanation of my invention as well as being covered by certain of the claims in this application, I have illustrated my invention more elaborately in an electrical apparatus for producing unidirectional discharges of high potential.

In the drawings Fig 1 is a view, partly in perspective and largely diagrammatic, of one form of machine embodying my invention;

Fig 2 is a vertical cross-sectional view showing the most approved form of two of the cooperating electrodes;

Fig 3 illustrates the application thereof for transforming an intermittent current into a constant current;

[*Price* 8*d*.]

Fig 4 illustrates the application of my invention to Leyden jars for converting an intermittent discharge into a continuous discharge.

Referring now more particularly to Fig 2, in order that the foundation idea of my invention may be first clearly understood, it will be seen that the electrode *a* is pointed or pencil shaped and that the extreme discharge point *b* is in or projected slightly through a small aperture *c* in a rubber or other flat disc *d* which extends at right angles thereto, the purpose of this disc being to cut off the attracting area which would otherwise be present in the converging walls or surfaces of the electrode *a*.

By this means I provide an extensionless point, speaking electrically. By this term, I mean a point in which the attractive area of the electrode relatively to the opposite electrode is limited to the point itself or, in other words, in which the rubber disc *d* shields all the surface of the rod or electrode behind the very point thereof.

The rubber disc constitutes means for cutting off the receptive area about the discharge point.

Opposite the electrode point *b* is the receptive electrode *e* which maintains a negative condition relatively to the electrode *a*, and which I have termed the limitless plane, speaking again electrically, this electrode having a large receptive area and being provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface or plane without angles or points, and this plane is secured by providing a flat surface *f* of considerable relative extent and curving its edges back and inwardly as indicated at *g*, whereby, viewed electrically, the surface is limitless inasmuch as it has no termination within the influence of the discharge point *b*.

In operation, the positive energy discharges invariably from the point *b* to the plane *f* and there is no discharge from the latter back to the point, one reason therefor being that the attraction of the limitless plane is compelling, there being practically no attraction in the opposite direction, due to the shielded point.

From the foregoing the extensionless point and limitless plane feature, which is at the basis of my invention, will be readily understood, and it will be seen that its field is important and large.

For example, in Fig 3 I have indicated a typical source of intermittent or alternating energy in the form of an induction coil *h* (operated by an alternating current) whose terminals *i*, *j*, are provided with electrodes *a*, *e*, of the kind already described, and opposite these electrodes which are arranged in pairs are complementary electrodes *e a*, connected to a working circuit *k* which it is desired shall have a continuous current.

Remembering that, as already explained, the extensionless point and limitless plane electrodes compel the discharge to take place in one direction, it will be seen that the intermittent or alternating discharge from the coil *h* is automatically transferred into a continuous current by the lower sets of electrodes as arranged in Fig 3.

Referring now to Fig 1, where I have shown a more complete machine constructed to employ my invention in an elaborate manner, I have mounted on suitable insulating posts 2 a series of these electrodes *a*, *e*, arranged in opposite sets, there being herein shown three pairs in each set, on opposite sides of the machine.

On the right hand side of the machine the point electrodes are mounted in a rail 3 and screened by a shield 4 (although they may be screened by any other suitable means, as may be convenient, and, in fact, the machine will operate to advantage for some purposes without any screen), and the plane electrodes are mounted in a conductor rod 5, while on the opposite side of the machine the arrangement is reversed, the plane electrodes *e* being mounted in the rail 3, and the point electrodes in the rod 5.

In a suitable position, herein shown as the end of the right hand rod 5, is

mounted a point electrode a^1, and opposite thereto mounted in the opposite rod 5 is a plane electrode e, while suitably connected thereto is any form of apparatus with which it may be desired to use the machine, herein shown as a condenser 6 connected by wires 7, 8, to the conductor rods 5.

On the base or table 9 are carried a plurality of high potential generating units, as they may be called, herein shown as usual induction coils 10, 12, 13, the terminals of whose secondaries are connected respectively to the lower set of electrodes immediately above them, as is clearly shown, and whose primaries are connected to a battery or other current source 14, an interrupter m being interposed in the circuit and a series of condensers 15, 16, 17, being properly interposed.

The condensers may be thrown into the circuit, as may be desired, by switches n, n^1, n^2.

While the machine will work with other forms of interrupters, yet for the best efficiency thereof I have found it necessary to employ a special interrupter consisting of a cup m^1 provided with a quantity of mercury m^2, above which is a bath of kerosene oil m^3.

A fixed conductor m^4 from the interrupter m leads into the mercury, and above the same is arranged a series of plungers or contact makers m^5, m^6, m^7, connecting respectively with the several high potential units 10, 12, 13, and operated by a shaft m^8 driven by any suitable means, as by a motor m^9, belt m^{10} and pulley m^{12}.

On the shaft m^8 are eccentrics m^{13} relatively adjustable by means of set screws m^{14}.

I have described my mechanism in all its preferred details of construction, as herein embodied, but it will be understood that many changes and substitutions may be resorted to without departing from the spirit and scope of my invention, and that the form and general make up of the apparatus will usually be modified to conform to the particular situation and purpose for which it is intended.

The operation is as follows When quantitative effect of discharge is desired, the interrupter is set as shown, the eccentrics all being placed the same, so that the coils are all broken simultaneously, the coils being in multiple, and thereby the lower electrodes a at the right hand, simultaneously discharge their respective coils, and this combined discharge is received by the opposite electrodes e and conveyed by the conductor 5, thereby giving an enormous discharge from the point a^1 to the receiving electrode e^1, the circuit being completed therefrom through the upper electrode a to the electrode e, and meanwhile the condenser 6 is charged, according to its capacity.

If, on the other hand, continuity of discharge is desired, the eccentrics m^{13} are adjusted in step with each other, so that the interruptions in the mercury cup are made dissimultaneously, or in succession, thereby discharging the coils 10, 12, 13, successively, and hence producing a continuous discharge between the electrodes a^1, e^1, this discharge being at a given voltage, according to the capacity of the condenser 15, 16, 17, or such part thereof as may be used.

By having a plurality of induction devices or high potential generators arranged in step in connection with the point and plane electrodes, I am enabled to obtain a continuous discharge, yet employ a slow interruption, the result being that a maximum output is made certain.

This result has not heretofore been feasible, as it would be necessary to operate the interrupter with great rapidity in order to get the high potential required, and when the interruptions of a coil are exceedingly rapid the output from the secondary, as is well known, is below its capacity.

This invention makes possible obtaining a purely direct discharge, *i.e.*, free from oscillations, such as has heretofore been obtained only from a static machine; accomplishes the handling or control of any quantity, however great, of high potential current; is a most powerful generator for X-ray work, and ideal in its control of the quality of X-rays, on account of the discharge being

wholly in one direction, continuous, and from a condenser; besides various other advantages which will occur to those skilled in the art.

In Fig 4 I have illustrated my electrode invention applied to two Leyden jars 18 having their outer coatings electrically connected by a wire 19 and their inner coatings connected by posts *p* in which are mounted usual discharge rods *r*, said posts, however, being provided on their upper extremities with the electrodes *a*, *e*; opposite to electrodes *e*, *a*, at the terminals of a coil *h* (operated by an interrupted current).

By this means, it is possible to maintain constant discharge at an approximately fixed potential similar to the discharge from a static machine, as the intermittent discharge from the induction coil which is the source of supply for the Leyden jars, is enabled to keep the Leyden jars at a practically saturated point, so that the latter can maintain a constant discharge between their rods *r*.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. The herein described means for producing a continuous or unidirectional discharge, consisting of electrodes one of which has a discharge point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge, as set forth.

2. An electrode terminating in a plane conducting surface, having its edges curved or rolled rearwardly and inwardly.

3. An electrode terminating in a comparatively fine point, and a flat shield extending approximately at right angles to said electrode and having a small aperture in which said point is located.

4. In an electrical apparatus, a source of intermittent electrical energy having at its opposite terminals electrodes one of which has a discharge point provided with means for cutting off the receptive area about said discharge point and the other of which has a large receptive area provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface without angles or points, and other electrodes cooperating with said terminal electrodes, there being a discharge point electrode arranged to cooperate with a receptive area electrode and *vice versa*.

5. An electrical apparatus, comprising a plurality of high potential generating units, and means uniting them in a unidirectional discharge.

6. An electrical apparatus, comprising a plurality of high potential generating units, means for giving them a unidirectional discharge, and mechanism for discharging them simultaneously or dissimultaneously, as desired.

7. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, and a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury

8. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury, and means for varying the movement of said contact makers with relation to each other.

9. An electrical apparatus comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup

having a series of movable contact makers movable in oil above said mercury, said condenser having a plurality of independent parts, and switching mechanism for throwing said parts independently into the circuit of said primaries.

Dated the 18th day of June 1901.

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55 & 56 Chancery Lane London
Agents for the Applicant

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A.D. 1901. JUNE 18. N° 12,408.
KINRAIDE'S COMPLETE SPECIFICATION

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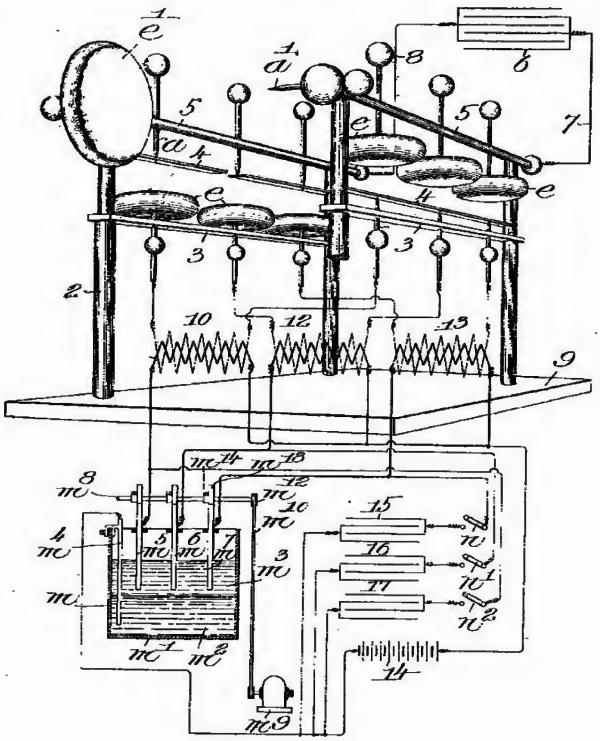
Fig. 1.



SHEET 2

Fig. h.

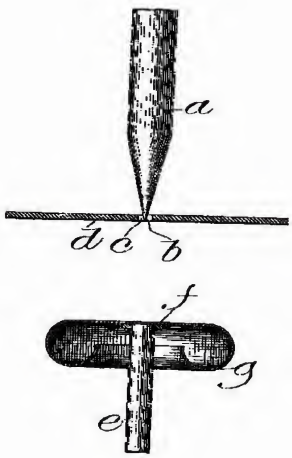


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Fig. 1.

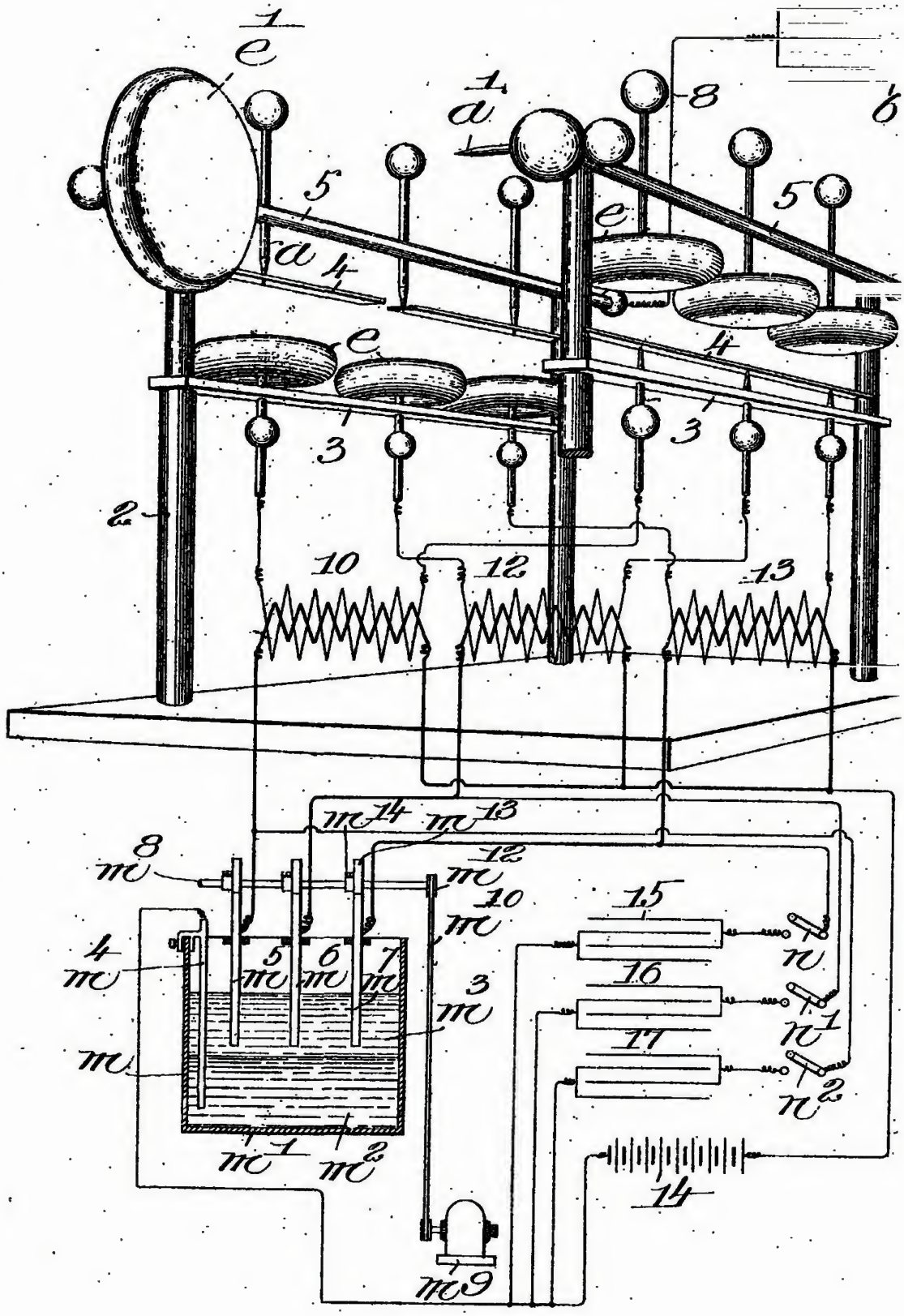
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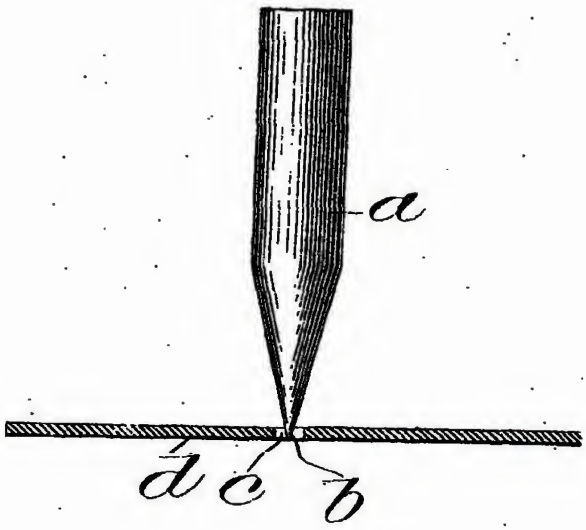
Fig. 2.



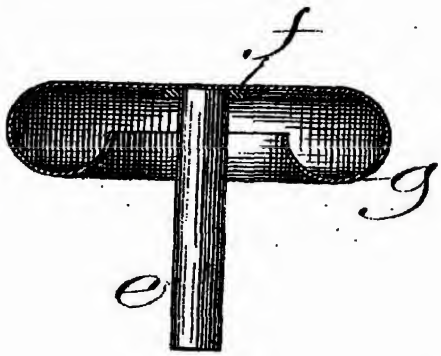


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Fig. 3.

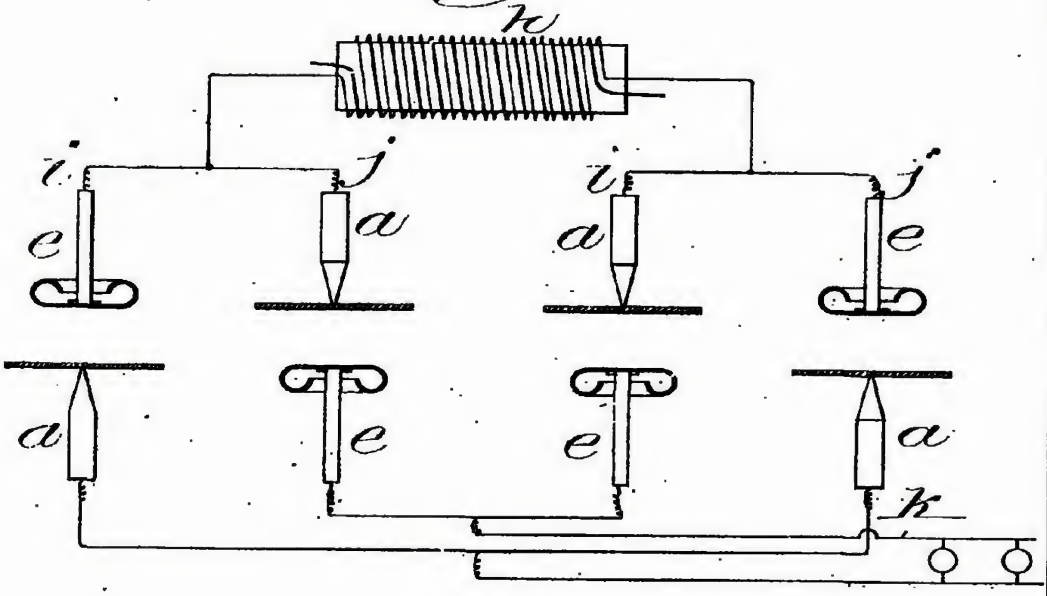
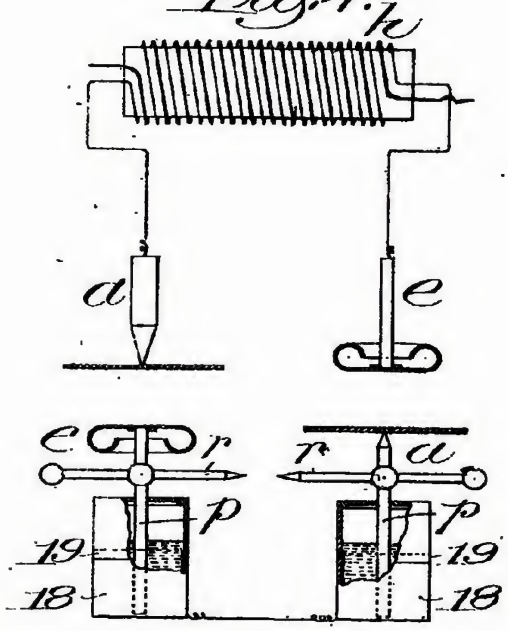


Fig. 4.



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